VOLUME 14, 1921

# JOURNAL

OF

# ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS



Published by
AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS
GENEVA, N. Y.

# CONTENTS

At the election of officers at the May meeting of the Division, your representative was elected a member of the executive committee for the current year.

At a conference, held in Albany, N. Y., on April 19 there was submitted for consideration by the Committee of Policy two investigational projects as follows: 1, Suggested Plan for Investigation of Permanent Pasture and Meadow by Dr. Herbert Osborn; and 2, Investigation of Forest Insects by Dr. W. A. Riley. Both problems were heartily commended; but, it was deemed unwise to refer them at this time to the Council for approval as no funds were available to support the investigations.

The National Research Council is primarily a congress of the scientists of the country, and its organization is largely based on the national scientific societies. Projects are carried on by men who come in contact with the Council someway or other through the various scientific organizations. As regards financial support, the endowment provides for funds for administrative purposes and does not allow large sums of money for specific pieces of research. At the present time, it is largely the task of the societies to secure funds for their individual projects. The establishment of this policy, together with the successful efforts of various groups of workers in securing financial support for their specific undertakings, were the chief factors, that prompted the organization of the Crop Protection Institute.

While funds have not yet been obtained for the support of the foregoing projects, only good can develop from efforts that focus attention on them. Constant emphasis of promising problems should eventually lead to constructive activities, whereas if these are left to the accidents of individual initiative, action may be indefinitely postponed.

The Research Council serves a most useful function in promoting cooperation, coordination and correlation of scientific efforts and in encouraging collective action by the different societies of a kind not heretofore generally attempted by individuals or by private and public institutions. Through its assistance the Committee of Entomology can render important service in encouraging research in the field of entomology. With adequate financial support, it should also be able to conduct large cooperative activities among entomologists, having as their object field demonstration of scientific results and standardization of control measures, which are applicable to large geographical areas; efforts that receive little encouragement or financial aid from existing institutions. There also exists a large opportunity for enlisting the support of men of affairs, who can assist in coordinating civilian enterprises with entomological activities and shaping public sentiment in its judgment of the character and efficiency of entomological efforts in behalf of national welfare. Industrial concerns, individually and collectively, are prepared to grant funds for the investigation of special practical problems. Conferences between entomologists and representatives of industrial enterprises afford also opportunity for the exchange of ideas and advantageous consultation, which should result in the speeding up of research and experimental activities on problems of outstanding importance. Careful consideration needs to be given to the fundamental principles involved in these undertakings, and to the development of detailed plans, which will insure efficient direction of the approved projects.

There is a manifest need for greater unification of efforts, that the agricultural industry may feel the force of our work in solid impact, not singly at special points here and there but along the whole front. Entomologists have exceptional opportunities to develop a demonstration of whole-hearted cooperation in tasks related to the welfare of agriculture. Discerning workers will surely not fail to lend their support in fostering mutual confidence and good will in cooperative effort, which will make the Association a more productive servant of the country.

In conclusion, I wish to acknowledge my deep appreciation of the honor of representing the Association in the Division of Biology and Agriculture of the Council This institution is only in its infancy: and much preliminary spade-work has of necessity had to be done. Many tasks have yet to be tackled, which are destined to yield results of great interest and value when far-seeing men apply their minds to the task.

Respectfully submitted,

PERCIVAL J. PARROTT

Action on this report was deferred so that it could be considered with the report of the committee on policy.

PRESIDENT WILMON NEWELL: The report of the committee on nomenclature will be presented by Mr. Z. P. Metcalf.

## REPORT OF THE COMMITTEE ON NOMENCLATURE

In accordance with the instructions of the Association at the St. Louis meeting, this committee has prepared for publication the list of all the common names of insects which have been passed upon and accepted by the Association up to and including the St. Louis meeting.

It is the sentiment of the committee, however, that, since the list as it stands is evidently in need of editorial revision for uniformity in use of hyphens as well as in certain other particulars, it would be unfortunate to have the list reprinted without further consideration by the Association. The present committee has not felt that editing the list in such a way as to change the words as recommended by previous committees and already accepted by the vote of the Association would come within its province.

With reference to the perplexities which the present committee have experienced, the three following may be cited by way of example:

1. We seem to be without guidance as to rules to word formation, in view of the fact that the Association has by committee recommendation and by vote accepted "Colorado potato-beetle" (with hyphen) and "Colorado pine beetle" (without hypen); "Locust-borer" and "Poplar borer"; "Beet leaf-hopper" and "Saddled leafhopper"; "Army-worm" and "Fall armyworm", etc., etc., etc.

2. The question as to whether names sanctioned should be equally applicable in all parts of the country seems to merit consideration. At present the Southern entomologists are asked to use "fall armyworm" for an insect injurious in May and "fall web-worm" for an insect whose larva becomes full fed in June.

3. The question of name length is perhaps also in need of consideration.

In view of the difficulties which have seemed to balk the progress of this work the committee recommends that the matter of nomenclature be assigned to a committee who will continue until a list of say 1000 names be completed. It would of course be understood that such a committee should not be under pressure of haste and that they should consult by correspondence or otherwise with many of the members to get their views on the adoption of certain names.

Respectfully submitted,

EDITH M. PATCH
Z. P. METCALF
ARTHUR GIBSON
*Committee*

Voted that the report be accepted, and the recommendations adopted. It is understood that this committee should continue as a permanent committee until the work on common names of insects is completed.

PRESIDENT WILMON NEWELL: The report of the committee on Index of Economic Entomology will be given by Mr. E. P. Felt.

## REPORT OF THE COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

Your Committee would report the completion early in the year of the manuscript for the years 1915 to 1919 inclusive. It would state that it has been turned over to the editorial board of the JOURNAL OF ECONOMIC ENTOMOLOGY in accordance with the action of the last annual meeting.

The committee would also voice its hearty approval of the liberal policy pursued by Dr. L. O. Howard, Chief of the Bureau of Entomology, in authorizing the preparation of this index.

This Committee further wishes to place on record its grateful appreciation of the earnest and accurate work of Miss Mabel Colcord, in charge of the project, and her associates. They have rendered invaluable services to economic entomologists not only of this country but of the world. It is difficult for one unfamiliar with work of this character to appreciate the amount of labor involved and it is therefore recommended that a special vote of thanks be given Miss Colcord and those who assisted in preparing the index as a slight recognition of their part in a laborious and usually somewhat thankless task.

It should be noted that the indebtedness incurred in the publication of the Bank's Index has been liquidated and a similar outcome is anticipated in the case of the Colcord Index.

Extended indices to the voluminous and scattered records of economic entomology are of immense service to all economic workers. Although the publication of the Colcord index was more expensive than was anticipated, the Committee believes that such aids are worth all that they cost and in spite of abnormally high prices now current, it is our opinion that future probabilities should be taken into account and with these in view, it is recommended that the Committee be continued and directed to carefully study the situation in order to ascertain possibilities for more frequent publication of such indices, either by this Association or through some other agency.

Respectfully submitted,

E. P. FELT
A. F. BURGESS
W. C. O'KANE
W. E. BRITTON
W. E. HINDS
*Committee*

Voted that the report of the committee be adopted.

PRESIDENT WILMON NEWELL: I will appoint the following committees:

Auditing committee: W. R. Walton, J. W. McColloch.

Resolutions committee: A. G. Ruggles, Arthur Gibson and M. C. Tanquary.

Nominations committee: J. J. Davis, C. L. Metcalf and J. E. Graf.

Is there any miscellaneous business?

MR. W. E. HINDS: I would like to make a statement concerning the Entomologists Employment Bureau.

## ENTOMOLOGISTS EMPLOYMENT BUREAU

### STATEMENT RELATIVE TO WORK OF 1920 AND PRESENT STATUS

By W. E. HINDS

At the annual meeting of the Association of Economic Entomologists in December 1919, it was voted first, in effect, to continue the Employment Bureau. Later, through the adoption of a resolution presented by the Committee on Resolutions action was taken to discontinue the Bureau. In view of the uncertainty as to the actual desire and purpose of the Association, and in consideration of the fact that the Association was under no financial obligation whatever in the matter as the report showed a small balance in the treasury at the time, and in view also of the fact that at the time this action was taken numerous references were in process of being completed, the work was continued upon the personal responsibility of the one who had been in charge of it for a number of years. The work was continued in the belief that there would be no objection on the part of the Association to such service being given as might be given under the circumstances but with the purpose to close up the work of the Bureau during the year in accordance with the second action of the last meeting.

During the year several enrollments were offered and in most, I believe in all, cases these were declined. However two or possibly three checks were at hand and awaiting return to the applicants when, unfortunately, the entire records of the Bureau were destroyed by fire in the burning of the Agricultural Building at Auburn on October 17, 1920. Thus were lost all enrollment records of some sixty or seventy men and all record of references given and of the financial work of the Bureau.

There seems therefore to be no possibility at this time of checking up the work of the Bureau with any degree of accuracy. The writers of uncashed checks will, of course, discover that fact in time through the failure of their banks to return the checks, but it is utterly impossible for us either to list the names of those enrolled or to tell how many references have been given to those whose names might be recalled.

As the members of the Association doubtless know, the work of the Bureau has been carried on for many years entirely as a disinterested and non-profit making service to all interested entomologists, both employers and employees. The balance of cash on hand a year ago was $58.93 according to the printed report in the JOURNAL OF ECONOMIC ENTOMOLOGY. The expense from Dec. 24, 1919 to May 15, 1920 is definitely known and is as stated below in the financial statement. The work of the balance of the year is estimated to have been equal to that for the first five months and payments for stenographic service, etc., have been made accordingly.

Under the circumstances no new enrollments will be received and no further references can be given. We would ask the Association to decide what disposition shall be made of the balance of cash on hand, as shown in the following statement.

[1]Withd[illegible]sewhere.

## AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

(Organized 1889, Incorporated December 29, 1913)

OFFICERS, 1921

President
GEORGE A. DEAN, Manhattan, Kansas

First Vice-President
ARTHUR GIBSON, Ottawa, Canada

Second Vice-President (Pacific Slope Branch)
E. O. ESSIG, Berkeley, California

Third Vice-President (Horticultural Inspection)
A. G. RUGGLES, St. Paul, Minnesota

Fourth Vice-President (Apiculture)
H. F. WILSON, Madison, Wisconsin

Secretary
A. F. BURGESS, Melrose Highlands, Massachusetts. Term expires 1923

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PACIFIC SLOPE BRANCH

Secretary
A. L. LOVETT, Corvallis, Oregon

SECTION OF HORTICULTURAL INSPECTION

Secretary
E. R. SASSCER, Washington, District of Columbia

SECTION OF APICULTURE

Secretary
G. M. BENTLEY, Knoxville, Tennessee

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STANDING COMMITTEES

Committee on Policy.

WILMON NEWELL, Chairman, Gainesville, Florida. Term expires 1925.
GEORGE A. DEAN, Manhattan, Kansas. Ex-officio.
A. F. BURGESS, Melrose Highlands, Massachusetts. Ex-officio.
E. P. FELT, Albany, New York. Ex-officio.
P. J. PARROTT, Geneva, New York. Ex-officio.
W. C. O'KANE, Durham, New Hampshire. Term expires 1924.
E. D. BALL, Ames, Iowa. Term expires 1923.
HERBERT OSBORN, Columbus, Ohio. Term expires 1922.
W. D. PIERCE, Denver, Colorado. Term expires 1921.

Committee on Nomenclature.

EDITH M. PATCH, Chairman, Orono, Maine. Term expires 1923.
Z. P. METCALF, West Raleigh, North Carolina. Term expires 1921.
ARTHUR GIBSON, Ottawa, Canada. Term expires 1922.

Committee on Membership.

E. R. SASSCER, Chairman, Washington, District of Columbia. Term expires 1921.
A. G. RUGGLES, St. Paul, Minnesota. Term expires 1922.
J. S. HOUSER, Wooster, Ohio. Term expires 1923.

Committee on the U. S. National Museum.

J. J. DAVIS, Chairman, LaFayette, Indiana. Term expires 1923.
HERBERT OSBORN, Columbus, Ohio. Term expires 1925.
W. J. HOLLAND, Pittsburgh, Pennsylvania. Term expires 1924.
V. L. KELLOGG, Washington, District of Columbia. Term expires 1922.
E. P. FELT, Albany, New York. Term expires 1921.

Representative to National Research Council.

P. J. PARROTT, Geneva, New York.

Councillors for the American Association for the Advancement of Science.

T. J. HEADLEE, New Brunswick, New Jersey.
A. L. QUAINTANCE, Washington, District of Columbia.

Trustees for Crop Protection Institute.

W. C. O'KANE, Durham, New Hampshire. Term expires 1923.
P. J. PARROTT, Geneva, New York. Term expires 1922.
J. G. SANDERS, Harrisburg, Pennsylvania. Term expires 1921.

## LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President C. V. Riley; First Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting.)

Third Annual Meeting, Washington, D. C., Aug. 17–18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15–16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14–16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14–15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27–28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21–22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12–13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19–20, 1898. President, Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio. Aug. 18–19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22–23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23–24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27–28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26–27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29–31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29–30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1–4, 1906. President, H. Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28–29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27–28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28–29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28–29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28–29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D. C., Dec. 27–29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1–3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913–Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelphia, Pa., Dec. 28–31, 1914. President H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9–10, 1915. (Officers same as for Twenty eighth Annual Meeting.)

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27–30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28–30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917–Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26–27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Louis, Mo., Dec. 31, 1919–Jan. 2, 1920. President, W. C. O'Kane; First Vice-President, A. G. Ruggles; Second Vice-President, H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

Thirty-third Annual Meeting, Chicago, Ill., Dec. 29–31, 1920. President, Wilmon Newell; First Vice-President, H. A. Gossard; Second Vice-President, E. M. Ehrhorn; Third Vice-President, J. G. Sanders; Fourth Vice-President, F. B. Paddock; Secretary, A. F. Burgess.

## LIST OF MEMBERS

### ACTIVE MEMBERS

1 Abbott, W. S., U. S. Bureau of Entomology, Vienna, Va.
2 Ainslie, C. N., 5009 Orleans Ave., Sioux City, Iowa.
3 Ainslie, George G., R. R. 9, Knoxville, Tenn.
4 Aldrich, J. M., U. S. National Museum, Washington, D. C.
5 Armitage, H. M., 827 N. Olive St., Alhambra, Calif.
6 Atwood, George G., Division of Agriculture, Albany, N. Y.
7 Back, E. A., U. S. Bureau of Entomology, Washington, D. C.
8 Baker, A. C., U. S. Bureau of Entomology, Washington, D. C.
9 Baker, A. W., Ontario Agricultural College, Guelph, Canada.
10 Baker, C. F., Los Banos, P. I.

11 Ball, E. D., Iowa Agricultural College, Ames, Iowa.
12 Banks, C. S., Bureau of Science, Manila, P. I.
13 Banks, Nathan, Museum of Comparative Zoology, Cambridge, Mass.
14 Barber, E. R., Audubon Park, New Orleans, La.
15 Barber, H. S., U. S. Bureau of Entomology, Washington, D. C.
16 Barber, T. C., Box 639, Brownsville.,Tex.
17 Becker, G. G., State Plant Board, Little Rock, Ark.
18 Bentley, G. M., University of Tennessee, Knoxville, Tenn.
19 Berger, E. W., University of Florida, Gainesville, Fla.
20 Bethune, C. J. S., Guelph, Ontario, Canada.
21 Bishopp, F. C., U. S. Bureau of Entomology, Dallas, Texas.
22 Blackman, M. W., N. Y. State College of Forestry, Syracuse, N. Y.
23 Bourne, A. I., Agricultural Experiment Station, Amherst, Mass.
24 Brittain, W. H., Truro, N. S.
25 Britton, W. E., Agricultural Experiment Station, New Haven, Conn.
26 Brooks, F. E., U. S. Bureau of Entomology, French Creek, W. Va.
27 Brues, C. T., Bussey Institution, Forest Hills, Boston, Mass.
28 Bruner, Lawrence, Agricultural Experiment Station, Lincoln, Neb.
29 Burgess, A. F., U. S. Bureau of Entomology, Melrose Highlands, Mass.
30 Burke, H. E., Los Gatos, Calif.
31 Burrill, A. C., Agricultural Extension Service, Columbia, Mo.
32 Busck, August, U. S. National Museum, Washington, D. C.
33 Caesar, Lawson, Ontario Agricultural College, Guelph, Canada.
34 Caffrey, D. J., 10 Court St., Arlington, Mass.
35 Cameron, A. E., University of Saskatchewan, Saskatoon, Sask.
36 Campbell, R. E., 200 S. Third St., Alhambra, Calif.
37 Caudell, A. N., U. S. National Museum, Washington, D. C.
38 Chandler, W. L., East Lansing, Mich.
39 Chapman, R. N., Department of Animal Biology, University of Minnesota. Minneapolis, Minn.
40 Chase, W. W., State Capitol, Atlanta, Ga.
41 Childs, LeRoy, Hood River, Ore.
42 Chittenden, F. H., U. S. Bureau of Entomology, Washington, D. C.
43 Clausen, C. P., 2301 Hearst Ave., Berkeley, Calif.
44 Cleveland, C. R., New Hampshire College, Durham, N. H.
45 Coad, B. R., U. S. Bureau of Entomology, Tallulah, La.
46 Cockerell, T. D. A., Boulder, Colo.
47 Cole, F. R., R. F. D. Box 177, Redlands, Calif.
48 Collins, C. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
49 Comstock, J. H., Cornell University, Ithaca, N. Y.
50 Conradi, A. F., Clemson College, S. C.
51 Cook, Mel T. ,Agricultural Experiment Station, New Brunswick, N. J.
52 Cooley, R. A., Agricultural Experiment Station, Bozeman, Mont.
53 Cory, E. N., Agricultural Experiment Station, College Park, Md.
54 Cotton, E. C., Department of Agriculture, Columbus, Ohio.
55 Cotton, R. T., Box 259, Orlando, Fla.
56 Crampton, G. C., Agricultural College, Amherst, Mass.
57 Crawford, D. L., College of Hawaii, Honolulu, H. T.
58 Creel, C. W., University of Nevada, Reno, Nev.
59 Criddle, Norman, Treesbank, Manitoba, Can.
60 Crosby, C. R., Cornell University, Ithaca, N. Y.

61 Crossman, S. S., U. S. Bureau of Entomology, Melrose Highlands, Mass.
62 Davidson, William, Vienna, Va.
63 Davis, I. W., Danielson, Conn.
64 Davis, J. J., Agricultural Experiment Station, La Fayette, Ind.
65 Dean, George A., Agricultural Experiment Station, Manhattan, Kan.
66 DeLong, Dwight M., Bureau of Plant Industry, Harrisburg, Pa.
67 Dietz, H. F., 3225 Boulevard Pl., Indianapolis, Ind.
68 Doane, R. W., Stanford University, Calif.
69 Ehrhorn, E. M., Honolulu, H. T.
70 Essig, E. O., University of California, Berkeley, Calif.
71 Ewing, H. E., U. S. National Museum, Washington, D. C.
72 Felt, E. P., State Museum, Albany, N. Y.
73 Fenton, F. A., Iowa Agricultural College, Ames, Iowa.
74 Fernald, C. H., Agricultural College, Amherst, Mass.
75 Fernald, H. T., Agricultural College, Amherst, Mass.
76 Ferris, G. F., Stanford University, Calif.
77 Fink, D. E., Riverton, N. J.
78 Flint, W. P., 1306 S. Orchard St., Urbana, Ill.
79 Forbes, S. A., University of Illinois, Urbana, Ill.
80 Ford, A. L., Extension Division, Brookings, S. D.
81 Foster, S. W., 201 Sansome St., San Francisco, Calif.
82 Fox, Henry, Mercer University, Macon, Ga.
83 Fracker, S. B., State Capitol, Madison, Wis.
84 Franklin, H. J., East Wareham, Mass.
85 Freeborn, S. B., University of California, Berkeley, Calif.
86 Frost, S. W., Research Laboratory, Arendtsville, Pa.
87 Fullaway, D. T., Agricultural Experiment Station, Honolulu, H. T.
88 Fulton, B. B., Agricultural College, Corvallis, Ore.
89 Gahan, A. B., Berwyn, Md.
90 Garman, H., Agricultural Experiment Station, Lexington, Ky.
91 Garman, Philip, Agricultural Experiment Station, New Haven, Conn.
92 Gibson, Arthur, Entomological Branch, Ottawa, Canada.
93 Gill, John B., Box 229, Brownwood, Texas.
94 Gillette, C. P., Agricultural Experiment Station, Fort Collins, Colo.
95 Glasgow, Hugh, Agricultural Experiment Station, Geneva, N. Y.
96 Glenn, P. A., Office of State Entomologist, Urbana, Ill.
97 Goodwin, W. H., R. F. D., Wooster, Ohio.
98 Gossard, H. A., Agricultural Experiment Station, Wooster, Ohio.
99 Graf, J. E., Box 205, Biloxi, Miss.
100 Gray, George P., Department of Agriculture, Sacramento, Calif.
101 Hadley, Charles H., Jr., Entomological Laboratory, Riverton, N. J.
102 Hagan, H. R., University of Utah, Salt Lake City, Utah.
103 Hall, M. C., Division of Zoology, Bureau Animal Industry, Washington, D. C.
104 Harned, R. W., Agricultural College, Miss.
105 Hartzell, F. Z., Agricultural Experiment Station, Fredonia, N. Y.
106 Haseman, Leonard, Agricultural Experiment Station, Columbia, Mo.
107 Hawley, I. M., Cornell University, Ithaca, N. Y.
108 Hayes, W. P., Agricultural Experiment Station, Manhattan, Kan.
109 Headlee, T. J., Agricultural Experiment Station, New Brunswick, N. J.
110 Herbert, F. B., Los Gatos, Calif.
111 Herms, W. B., University of California, Berkeley, Calif.

112 Herrick, Glenn W., Cornell University, Ithaca, N. Y.
113 High, M. M., U. S. Bureau of Entomology, Kingsville, Tex.
114 Hinds, W. E., Agricultural Experiment Station, Auburn, Ala.
115 Hine, J. S., Ohio State University, Columbus, Ohio.
116 Hodgkiss, H. E., Botany Building, State College, Pa.
117 Holland, W. J., Carnegie Museum, Pittsburgh, Pa.
118 Holloway, T. E., U. S. Bureau of Entomology, Audubon Park, La.
119 Hooker, W. A., States Relation Service, Washington, D. C.
120 Hopkins, A. D., U. S. Bureau of Entomology, Washington, D. C.
121 Horton, J. R., 126 S. Minneapolis Ave., Wichita, Kan.
122 Houghton, C. O., Agricultural Experiment Station, Newark, Del.
123 Houser, J. S., Agricultural Experiment Station, Wooster, Ohio.
124 Howard, C. W., Canton Christian College, Canton, China.
125 Howard, L. O., U. S. Bureau of Entomology, Washington, D. C.
126 Howard, Neale F., 1519 12th Ave., South, Birmingham, Ala.
127 Hungerford, H. B. University of Kansas, Lawrence, Kan.
128 Hunter, S. J., University of Kansas, Lawrence, Kan.
129 Hunter, W. D., U. S. Bureau of Entomology, Washington, D. C.
130 Hyslop, J. A., U. S. Bureau of Entomology, Washington, D. C.
131 Illingworth, J. F., Gordonvale, near Cairns, North Queensland.
132 Isely, Dwight, U. S. Bureau of Entomology, Washington, D. C.
133 Johannsen, O. A., Cornell University, Ithaca, N. Y.
134 Johnson, S. A., Agricultural Experiment Station, Fort Collins, Colo.
135 Jones, C. R., Agricultural College, Fort Collins, Colo.
136 Jones, D. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
137 Jones, P. R., 350 California St., San Francisco, Calif.
138 Jones, T. H., Agricultural Experiment Station, Baton Rouge, La.
139 Kellogg, V. L., National Research Council, 1201 16th St., Washington, D. C.
140 Kelly, E. G., Agricultural College, Manhattan, Kan.
141 Kennedy, C. H., Ohio State University, Columbus, Ohio.
142 Kincaid, Trevor, University of Washington, Seattle, Wash.
143 King, J. L., 3233 Carnegie Ave., Cleveland, Ohio.
144 King, W. V., Mound, La.
145 Knight, H. H., University Farm, St. Paul, Minn.
146 Kotinsky, J., 519 Canal St., New Orleans, La.
147 Lamson, G. H., Jr., Agricultural College, Storrs, Conn.
148 Larrimer, W. H., Box 95, West LaFayette, Ind.
149 Larson, A. O., 200 S. 3d St., Alhambra, Calif.
150 Lathrop, F. H., Agricultural College, Corvallis, Ore.
151 Leiby, R. W., Department of Agriculture, Raleigh, N. C.
152 Leonard, M. D., Cornell University, Ithaca, N. Y.
153 List, G. M., Agricultural College, Fort Collins, Colo.
154 Lochhead, William, Macdonald College, Canada.
155 Loftin, U. C., Audubon Park, New Orleans, La.
156 Lovett, A. L., Agricultural College, Corvallis, Ore.
157 Lowry, Q. S., 2378 Washington St., Canton, Mass.
158 Luginbill, Philip, University of South Carolina, Columbia, S. C.
159 MacGillivray, A. D., University of Illinois, Urbana, Ill.
160 Mackie, D. B., 507 Union League Bldg., Los Angeles, Calif.
161 Marlatt, C. L., U. S. Bureau of Entomology, Washington, D. C.
162 Matheson, Robert, Cornell University, Ithaca, N. Y.

163 McColloch, J. W., Agricultural Experiment Station, Manhattan, Kan.
164 McDaniel, Eugenia, Agricultural College, East Lansing, Mich.
165 McGregor, E. A., El Centro, Calif.
166 McLaine, L. S., Entomological Branch, Ottawa, Can.
167 Melander, A. L., Agricultural College, Pullman, Wash.
168 Merrill, G. B., Gainesville, Fla.
169 Merrill, J. H., Agricultural Experiment Station, Manhattan, Kan.
170 Metcalf, C. L., Ohio State University, Columbus, Ohio.
171 Metcalf, Z. P., Agricultural Experiment Station, West Raleigh, N. C.
172 Milliken, F. B., Kirksville, Mo.
173 Moore, William, 1466 Hythe St., St. Paul, Minn.
174 Morgan, A. C., U. S. Bureau of Entomology, Clarksville, Tenn.
175 Morgan, H. A., Agricultural Experiment Station, Knoxville, Tenn.
176 Morrill, A. W., 382 West Ave., 53, Los Angeles, Calif.
177 Morrison, Harold, U. S. Bureau of Entomology, Washington, D. C.
178 Mosher, Edna, University of New Mexico, Albuquerque, N. Mex.
179 Mosher, F. H., U. S. Bureau of Entomology, Melrose Highlands, Mass.
180 Moznette, G. F., Box 1134, Miami, Fla.
181 Nelson, J. A., Mt. Vernon, Ohio.
182 Neuls, J. D., 715 Marsh-Strong Building, Los Angeles, Calif.
183 Newcomber, E. J., Box 243, Yakima, Wash.
184 Newell, Wilmon, State Plant Commission, Gainesville, Fla.
185 Nougaret, R. L., 2916 E. St., Sacramento, Calif.
186 Oestlund, O. W., University of Minnesota, Minneapolis, Minn.
187 O'Kane, W. C., Agricultural Experiment Station, Durham, N. H.
188 Osborn, Herbert, Ohio State University, Columbus, Ohio.
189 Osborn, H. T., Hawaiian Sugar Planters' Experiment Station, Honolulu, H. T.
190 Osburn, Raymond C., Ohio State University, Columbus, Ohio.
191 Packard, C. M., 600 26th St., Sacramento, Calif.
192 Paddock, F. B., State Apiarist, Ames, Iowa.
193 Parker, J. R., Agricultural Experiment Station, Bozeman, Mont.
194 Parker, R. R., Agricultural College, Bozeman, Mont.
195 Parks, T. H., Ohio State University, Columbus, Ohio.
196 Parrott, P. J., Agricultural Experiment Station, Geneva, N. Y.
197 Patch, Edith M., Agricultural Experiment Station, Orono, Me.
198 Peairs, L. M., Agricultural Experiment Station, Morgantown, W. Va.
199 Pellett, F. C., Hamilton, Ill.
200 Pemberton, C. E., U. S. Bureau of Entomology, Honolulu, H. T.
201 Perkins, R. C. L., 4 Thurlestone Rd., Newton Abbot, Devon, England.
202 Peterson, Alvah, Entomology Building, New Brunswick, N. J.
203 Pettit, Morley, Georgetown, Ontario, Canada.
204 Pettit, R. H., Agricultural Experiment Station, East Lansing, Mich.
205 Phillips, E. F., U. S. Bureau of Entomology, Washington, D. C.
206 Phillips, W. J., U. S. Bureau of Entomology, Charlottesville, Va.
207 Pierce, W. D., Box 1767, Denver, Colo.
208 Popenoe, C. H., U. S. Bureau of Entomology, Washington, D. C.
209 Quaintance, A. L., U. S. Bureau of Entomology, Washington, D. C.
210 Quayle, H. J., University of California, Riverside, Calif.
211 Reeves, George I., 1535 Edison St., Salt Lake City, Utah.
212 Regan, W. S., 84 Pleasant St., Amherst, Mass.
213 Richardson, C. H., Bureau of Entomology, Washington, D. C.

214 Riley, W. A., University Farm, St. Paul, Minn.
215 Rockwood, L. P., U. S. Bureau of Entomology, Forest Grove, Ore.
216 Ross, W. A., Vineland Station, Ontario, Canada.
217 Ruggles, A. G., University Farm, St. Paul, Minn.
218 Rumsey, W. E., Agricultural Experiment Station, Morgantown, W. Va.
219 Safro, V. I., Louisville, Ky.
220 Sanders, G. E., Entomological Branch, Annapolis Royal, N. S.
221 Sanders, J. G., Bureau Plant Industry, Harrisburg, Pa.
222 Sanderson, E. D., Cornell University, Ithaca, N. Y.
223 Sanford, H. L., Bureau of Entomology, Washington, D. C.
224 Sasscer, E. R., U. S. Bureau of Entomology, Washington, D. C.
225 Satterthwait, A. F., U. S. Bureau of Entomology, Webster Groves, Mo.
226 Scammell, H. B., Toms River, N. J.
227 Schoene, W. J., Agricultural Experiment Station, Blacksburg, Va.
228 Schwarz, E. A., U. S. National Museum, Washington, D. C.
229 Scott, E. W., Rockville, Md.
230 Seamans, H. L., State College, Bozeman, Mont.
231 Seigler, E. H., U. S. Bureau of Entomology, Washington, D. C.
232 Severin, H. C., Agricultural Experiment Station, Brookings, S. D.
233 Severin, H. H., 2310 Cedar St., Berkeley, Calif.
234 Shafer, G. D., 321 Melville Ave., Palo Alto, Calif.
235 Shelford, V. E., University of Illinois, Urbana, Ill.
236 Sherman, Franklin, Jr., Department of Agriculture, Raleigh, N. C.
237 Simanton, F. L., 549 Broadway, Benton Harbor, Mich.
238 Skinner, Henry, 1900 Race St., Philadelphia, Pa.
239 Smith, H. S., State Insectary, Sacramento, Calif.
240 Smith, L. V., Truck Experiment Station, Norfolk, Va.
241 Smith, R. I., 6 Beacon St., Boston, Mass.
242 Smulyan, M. T., U. S. Bureau of Entomology, Melrose Highlands, Mass.
243 Snyder, T. E., U. S. Bureau of Entomology, Washington, D. C.
244 Stearns, L. A., Leesburg, Va.
245 Strickland, E. H., Entomological Branch, Ottawa, Canada.
246 Summers, H. E., Agricultural Experiment Station, Ames, Iowa.
247 Summers, J. N., U. S. Bureau of Entomology, Melrose Highlands, Mass.
248 Surface, H. A., Mechanicsburg, Pa.
249 Swaine, J. M., Entomological Branch, Ottawa, Canada.
250 Swenk, M. H., Agricultural Experiment Station, Lincoln, Neb.
251 Swezey, O. H., Hawaiian Sugar Planters' Experiment Station, Honolulu, H. T.
252 Symons, T. B., Agricultural Experiment Station, College Park, Md.
253 Tanquary, M. C., College Station, Texas.
254 Taylor, E. P., University of Arizona, Tuscon, Ariz.
255 Timberlake, P. H., Hawaiian Sugar Planter's Experiment Station, Honolulu, H. T.
256 Titus, E. G., 673 6th Ave., Salt Lake City, Utah.
257 Tothill, J. D., Entomological Branch, Fredericton, N. B.
258 Treherne, R. C., Vernon, B. C.
259 Troop, James, Agricultural Experiment Station, LaFayette, Ind.
260 Tucker, E. S., Tallulah, La.
261 Urbahns, T. D., State Insectary, Sacramento, Calif.
262 Van Dine, D. L., Mound, La.
263 Van Dyke, E. C., University of California, Berkeley, Calif.

264 Van Zwaluwenberg, R. H., U. S. Bureau of Entomology, Charlottesville, Va.
265 Vickery, R. A., Route B, Box 21, San Antonio, Texas.
266 Viereck, H. L., Bureau Biological Survey, Washington, D. C.
267 Walden, B. H., Agricultural Experiment Station, New Haven, Conn.
268 Walton, W. R., U. S. Bureau of Entomology, Washington, D. C.
269 Washburn, F. L., University Farm, St. Paul, Minn.
270 Webb, J. L., U. S. Bureau of Entomology, Washington, D. C.
271 Webster, R. L., Cornell University, Ithaca, N. Y.
272 Weigel, C. A., Federal Horticultural Board, Washington, D. C.
273 Weiss, H. B., Agricultural Experiment Station, New Brunswick, N. J.
274 Weldon, G. P., Chaffee Union High School, Ontario, Calif.
275 Wheeler, W. M., Bussey Institution, Forest Hills, Boston, Mass.
276 Wildermuth, V. L., U. S. Bureau of Entomology, Tempe, Ariz.
277 Wilson, H. F., University of Wisconsin, Madison, Wis.
278 Woglum, R. S., California Fruit Growers' Exchange, Los Angeles, Calif.
279 Wolcott, G. N., Haina, Santo Domingo.
280 Wood, H. P., Box 208, Dallas, Texas.
281 Wood, W. B., U. S. Bureau of Entomology, Washington, D. C.
282 Woods, W. C., Wesleyan University, Middletown, Conn.
283 Yothers, M. A., 1514 N. Main St., Medford, Ore.
284 Yothers, W. W., U. S. Bureau of Entomology, Orlando, Fla.
285 Zappe, Max P., Agricultural Experiment Station, New Haven, Conn.
286 Zetek, James, Ancon, Canal Zone, Panama.

## ASSOCIATE MEMBERS

287 Ackerman, A. J., U. S. Bureau of Entomology, Washington, D. C.
288 Albert, Theodore, Chehalis, Wash.
289 Alden, C. H., Entomological Laboratory, Wallingford, Conn.
290 Allen, H. W., Agricultural College, Miss.
291 Allen, R. H., Board of Agriculture, State House, Boston, Mass.
292 Anderson, C. S., 10 Court St., Arlington, Mass.
293 Anderson, G. M., Clemson College, S. C.
294 Arnold, George F., Agricultural College, Miss.
295 Ayres, Ed. L., College Station, Texas.
296 Babcock, O. G., Box 322, Sonora, Texas.
297 Baerg, William J., Fayetteville, Ark.
298 Bailey, H. L., Bradford, Vt.
299 Bailey, I. L., Northboro, Mass.
300 Bailey, J. W., Agricultural College, Miss.
301 Balduf, W. V., Ohio State University, Columbus, Ohio.
302 Barber, G. W., 10 Court St., Arlington, Mass.
303 Barnes, P. T., 1726 Regina St., Harrisburg, Pa.
304 Barnes, William, Decatur, Ill.
305 Bartlett, Oscar C., Phoenix, Ariz.
306 Bartley, H. W., Sandwich, Mass.
307 Bauer, Frederick, Storrs, Conn.
308 Bazeley, W. A. L., 519 State House, Boston, Mass.
309 Beckwith, C. S., Agricultural Experiment Station, New Brunswick, N. J.
310 Bensel, G. E., Spreckels, Calif.
311 Beutenmuller, William, Box 258, Highwood, Bergen Co., N. J.

312 Beyer, A. H., Room 1101 Carney Bldg., 43 Tremont St., Boston, Mass.
313 Bilsing, S. W., College Station, Texas.
314 Black, A. B., Agricultural College, Corvallis, Ore.
315 Blakeslee, E. B., U. S. Bureau of Entomology, Washington, D. C.
316 Blanchard, E. E., San Isidro, Argentina.
317 Blanchard, R. A., Box 95, W. Lafayette, Ind.
318 Bower, L. J., 1535 Edison St., Salt Lake City, Utah.
319 Boyden, B. L., Daytona, Florida.
320 Bradley, W. G., Agricultural Experiment Station, Baton Rouge, La.
321 Braucher, R. W., 548 N. Pine Ave., Austin Station, Chicago, Ill.
322 Bridwell, J. C., Address unknown.
323 Brimley, C. S., Department of Agriculture, Raleigh, N. C.
324 Brinley, F. J., Entomological Laboratory, Riverton, N. J.
325 Brock, A. A., Santa Paula, Calif.
326 Brown, Luther, Agricultural College, Miss.
327 Brundett, H. M., 702 Carter Bldg., Houston, Texas.
328 Buck, J. E., Rural Retreat, Va.
329 Bynum, E. K., Ocean Springs, Miss.
330 Carpenter, H. B., care of State Entomologist, Albany, N. Y.
331 Carroll, Mitchell, Agricultural Experiment Station, New Brunswick, N. J.
332 Cartwright, William B., Box 283, Centralia, Ill.
333 Cassidy, T. P., Tallulah, La.
334 Chafin, Jeff, Gainesville, Fla.
335 Chamberlain, K. F., Cornwall Bridge, Conn.
336 Chamberlin, F. S., Quincy, Fla.
337 Chamberlin, T. R., 1525 Edison St., Salt Lake City, Utah.
338 Chambers, E. L., Dept. Entomology, Ohio State University, Columbus, Ohio.
339 Champlain, A. B., Bureau Plant Industry, Harrisburg, Pa.
340 Chandler, S. C., 402 W. Walnut St., Carbondale, Ill.
341 Chapman, J. W., Silliman Institute, Dumagueta, P. I.
342 Chrystal, R. N., Entomological Branch, Ottawa, Can.
343 Claason, P. W., 504 E. Buffalo St., Ithaca, N. Y.
344 Clapp, S. C., Mountain Branch Station, Swannanoa, N. C.
345 Coe, Wesley R., Yale University, New Haven, Conn.
346 Coleman, G. A., University of California, Berkeley, Calif.
347 Cook, William O., University Farm, St. Paul, Minn.
348 Corbett, G. H., The Gretna, Trowbridge, Wiltshire, England.
349 Craig, D. H., 10 Court St., Arlington, Mass.
350 Craighead, E. M., Bureau Plant Industry, Harrisburg, Pa.
351 Crawford, H. G., Entomological Branch, Ottawa, Canada.
352 Culver, J. J., Vienna, Va.
353 Currie, R. P., U. S. Bureau of Entomology, Washington, D. C.
354 Currier, D. L., Hall of Justice, San Jose, Calif.
355 Cushman, R. A., U. S. Bureau of Entomology, Washington, D. C.
356 Cutrer, T. H., Agricultural Experiment Station, Baton Rouge, La.
357 Darlington, P. S., Wenatchie, Wash.
358 Day, L. H., Hollister, Calif.
359 Dean, M. L., Olympia, Wash.
360 Del Curto, J. M., Department of Agriculture, Austin, Texas.
361 De Ong, E. R., Davis, Calif.
362 Deputy, O. D., Box 277, Laredo, Texas.

363 Detwiler, J. D., 117 Eddy St., Ithaca, N. Y.
364 Dickerson, E. L., 106 Prospect St., Nutley, N. J.
365 Dohanian, S. M., U. S. Bureau of Entomology, Melrose Highlands, Mass.
366 Dolbin, D. L., Box 680, Freeland, Pa.
367 Douglass, B. W., Trevlac, Ind.
368 Dove, W. E., U. S. Bureau of Entomology, Dallas, Texas.
369 Dozier, H. L., Agricultural College, Miss.
370 Drake, C. J., College of Forestry, Syracuse, N. Y.
371 Dudley, J. E., Jr., U. S. Bureau of Entomology, Madison, Wis.
372 Dusham, E. H., 419 W. College Ave., State College, Pa.
373 Eckert, J. E., Raleigh, N. C.
374 Eddy, M. W., U. S. Public Health Service, Perryville, Md.
375 Ellis, W. O., 10 Court St., Arlington, Mass.
376 Emery, W. T., San Benito, Texas.
377 Eyer, J. R., Girard, Pa.
378 Fackler, H. L., Knoxville, Tenn.
379 Farrar, Edward R., South Lincoln, Mass.
380 Fattig, P. W., Box 315, Gainesville, Fla.
381 Fisher, C. K., 126 S. Minneapolis Ave., Wichita, Kans.
382 Fisher, W. S., U. S. National Museum, Washington, D. C.
383 Fiske, R. J., Lunenburg, Mass.
384 Fluke, C. L., Jr., University of Wisconsin, Madison, Wis.
385 Fort, Harold M., Hamilton, Mo.
386 Frank, Arthur, West Washington Experiment Station, Puyallup, Wash.
387 Garrett, J. B., Negreet, La.
388 Garrison, Gwynn L., Tallulah, La.
389 Gentner, L. G., University of Wisconsin, Madison, Wis
390 Gibson, E. H., R. R. 1, Alexandria, Va.
391 Giffard, W. M., Box 308, Honolulu, H. T.
392 Gilbertson, G. J., Brookings, S. D.
393 Goodwin, James C., Box 138, Gainesville, Fla.
394 Graham, F. W., U. S. Bureau of Entomology, Melrose Highlands, Mass.
395 Graham, Samuel A., University Farm, St. Paul, Minn.
396 Gram, Ernest, Statens Plantspatologiske, Lyngby, Denmark.
397 Green, E. C., 923 W. Green St., Urbana, Ill.
398 Grimes, D. W., Agricultural College, Miss.
399 Gunderson, A. J., Cleveland, Ohio.
400 Guyton, Thomas L., Bureau of Plant Industry, Harrisburg, Pa.
401 Haber, V. R., 225 Lincoln Ave., Raleigh, N. C.
402 Hain, R. M., Agricultural College, East Lansing, Mich.
403 Ham, W. T., 19 Ware St., Suite 2, Cambridge, Mass.
404 Hamilton, C. C., State College, College Park, Md.
405 Hamlin, J. C., 702 Carter Bldg., Houston, Texas.
406 Hargreaves, Ernest, Imperial College of Science and Technology, S. Kensington London, S. W. 7, England.
407 Hartzell, Albert, Ames, Iowa.
408 Hawkins, Kenneth, Watertown, Wis.
409 Henderson, W. W., Agricultural Experiment Station, Logan, Utah.
410 Hertzog, P. H., Hightstown, N. J.
411 Hester, J. G., Box 1, Agricultural College, Miss.
412 Hill, C. C., 227 Moreland Ave., Carlisle, Pa.

413 Hoddy, E. J., 1713 Yale Ave., Knoxville, Tenn.
414 Hodson, B. E., 10 Court St., Arlington, Mass.
415 Hofer, C. E., 10 Court St., Arlington, Mass.
416 Hoffman, William A., care State Entomologist, Albany, N. Y.
417 Hoffmann, William E., Lawrence, Kans.
418 Holbrook, J. E. R., U. S. Bureau of Entomology, Melrose Highlands, Mass.
419 Hollinger, A. H., Address unknown.
420 Hollister, W. O., Kent, Ohio.
421 Hood, C. E., U. S. Bureau of Entomology, Melrose Highlands, Mass.
422 Hood, J. D., Biological Survey, Washington, D. C.
423 Horsfall, J. L., State College Laboratory, Bustleton, Pa.
424 Huber, L. L., Ohio State University, Columbus, Ohio.
425 Huckett, H. C., 804 E. Seneca St., Ithaca, N. Y.
426 Hudson, G. H., Plattsburg, N. Y.
427 Hunt, Chris M., Clearwater, Fla.
428 Hutson, J. C., Royal Botanic Gardens, Peradeniya, Ceylon.
429 Ingerson, H. G., 264 Brighton Road, Columbus, Ohio.
430 Jaenicke, Alex. J., U. S. Forest Service, Portland, Ore.
431 Jaques, H. E., Mt. Pleasant, Iowa.
432 Jewett, H. H., Agricultural Experiment Station, Lexington, Ky.
433 Jones, Edward R., Box 346, Clarksville, Tenn.
434 Jones, W. W., 700 McCormack Building, Salt Lake City, Utah.
435 Kannan, K. K., Stanford University, Calif.
436 Kelley, E. B., 214 Columbia Bldg., Spokane, Wash.
437 Kelty, R. H., Agricultural College, East Lansing, Mich.
438 Kidder, Nathaniel T., Milton, Mass.
439 Kimball, H. H., Agricultural College, Miss.
440 Kimsey, M. E., Address unknown.
441 King, K. M., Entomological Laboratory, Charlottesville, Va.
442 Kinsey, A. C., University of Indiana, Bloomington, Ind.
443 Kirk, H. B., 1902 North St., Harrisburg, Pa.
444 Kisliuk, Max, 134 S. 2d St., Philadelphia, Pa.
445 Knull, Josef N., Hammelstown, Pa.
446 Koebele, Albert, Waldkirch i Br., Baden, Germany.
447 Kraus, E. J., Experiment Station, Madison, Wis.
448 Laake, E. W., U. S. Bureau of Entomology, Dallas, Texas.
449 Landers, D. D., Nahant & Farm Sts., Wakefield, Mass.
450 Lane, Merton C., Box 498, Ritzville, Wash.
451 Langston, J. M., Agricultural College, Miss.
452 Lauderdale, J. L. E., Box 348, Phoenix, Ariz.
453 Leach, B. R., Entomological Laboratory, Riverton, N. J.
454 Ledyard, E. M., Salt Lake City, Utah.
455 Lee, Horace W., Tallulah, La.
456 Lewis, A. C., Capitol Building, Atlanta, Ga.
457 Lewis, C. W., 28 Albion St., Melrose Highlands, Mass.
458 Littler, F. M., 65 High St., Launceston, Tasmania.
459 Lobdell, R. N., Agricultural College, Miss.
460 Lockwood, Stewart, Agricultural College, N. D.
461 Mabee, W. B., Department of Agriculture, Raleigh, N. C.
462 Maheux, George, Department of Agriculture, Quebec, Canada.
463 Maloney, J. O., Agricultural College, Miss.

464 Mann, B. P., 1918 Sunderland Pl., Washington, D. C.
465 Manter, J. A., Connecticut Agricultural College, Storrs, Conn.
466 Marcovitch, S., Agricultural Experiment Station, Knoxville, Tenn.
467 Martin, J. F., Bureau Plant Industry, Washington, D. C.
468 Mason, A. C., Box 491, Orlando, Fla.
469 Mason, P. W., Bureau of Entomology, Washington, D. C.
470 Maxon, Asa C., Longmont, Calif.
471 McDonald, R. E., Department of Agriculture, Austin, Texas.
472 McDonough, F. L., Quincy, Fla.
473 McIntosh, Allen, Agricultural College, Miss.
474 McIntyre, H. L., 964 Main St., Melrose Highlands, Mass.
475 McMahon, E. A., 9 Delhousie St., Montreal, Can.
476 Menagh, C. S., U. S. Bureau of Entomology, Washington, D. C.
477 Mendenhall, E. W., 97 Brighton Rd., Columbus, Ohio.
478 Merrill, D. E., R. F. D. 6, Box 44, Guthrie Center, Iowa.
479 Miles, P. B., 1535 Edison St., Salt Lake City, Utah.
480 Millen, F. E., Apiculture Department, Guelph, Canada.
481 Miller, A. E., 67 W. 10th Ave., Columbus, Ohio.
482 Minott, C. W., Melrose Highlands, Mass.
483 Mitchell, T. B., Department of Agriculture, Raleigh, N. C.
484 Montgomery, J. H., State Plant Board, Gainesville, Fla.
485 Moreland, R. W., U. S. Bureau of Entomology, Tallulah, La.
486 Morse, A. P., Wellesley, Mass.
487 Muesebeck, C. F. W., Cornell University, Ithaca, N. Y.
488 Nakayama, Shonosuke, Imperial Plant Quarantine Station, Yokohama, Japan.
489 Ness, Henry, Ames, Iowa.
490 Newbegin, I. B., Wakefield, Mass.
491 Newton, J. H., Paonia, Colo.
492 Nickels, C. B., R. D. 1, Box 63, Charleston, S. C.
493 Nininger, H. H., Address unknown.
494 O'Bryne, F. M., Gainesville, Fla.
495 O'Rourke, F. L., 10 Court St., Arlington, Mass.
496 Osgood, W. A., New Hampshire College, Durham, N. H.
497 Paarman, J. H., 1532 Clay St., Davenport, Iowa.
498 Painter, H. R., Box 95, West LaFayette, Ind.
499 Palmer, R. G., Central Y. M. C. A., Rochester, N. Y.
500 Park, Wallace, Ames, Iowa.
501 Parker, H. L., 10 Court St., Arlington, Mass.
502 Parks, H. B., College Station, Texas.
503 Parman, D. C., Uvalde, Texas.
504 Partridge, N. L., Michigan Agricultural College, E. Lansing, Mich.
505 Peake, G. W., University Farm, St. Paul, Minn.
506 Pearson, G. B., Box 95, West LaFayette, Ind.
507 Peirson, H. B., Harvard Forest, Petersham, Mass.
508 Penny, D. D., Watsonville, Calif.
509 Phillips, Saul, Saugus, Mass.
510 Pillsbury, J. J., Board of Agriculture, Providence, R. I.
511 Plank, H. K., U. S. Bureau of Entomology, Washington, D. C.
512 Pollock, J. H., Box 423, Colorado Springs, Colo.
513 Poos, F. W., Entomological Laboratory, Charlottesville, Va.
514 Porter, B. A., U. S., Bureau of Entomology, Washington, D. C.

515 Powers, E. B., University of Nebraska, Lincoln, Neb.
516 Price, W. A., Purdue University, LaFayette, Ind.
517 Primm, James K., Oak Lane, Pa.
518 Rane, F. W., Clematis Ave., West Palm Beach, Fla.
519 Rea, George H., Cornell University, Ithaca, N. Y.
520 Reed, W. V., Capitol Building, Atlanta, Ga.
521 Reeher, Max M., Forest Grove, Ore.
522 Reese, C. A., Box 848, Charleston, W. Va.
523 Reinhard, H. J., College Station, Texas.
524 Reppert, R. R., College Station, Texas.
525 Ressler, I. L., Ames, Iowa.
526 Richardson, T. R., 43 Tremont St., Boston, Mass.
527 Ricker, D. A., Box 95, West LaFayette, Ind.
528 Robinson, C. L., Court House, Yakima, Wash.
529 Robinson, J. M., Experiment Station, Auburn, Ala.
530 Rogers, D. M., U. S. Bureau of Entomology, 6 Beacon St., Boston, Mass.
531 Rolfs, P. H., Bello Horizonte, Estado Minas Geraes, Brazil.
532 Root, E. R., Medina, Ohio.
533 Rosewall, O. W., State University, Baton Rouge, La.
534 Rounds, M. B., 824 N. Curtis Ave., Alhambra, Calif.
535 Ryan, H. J., 907 Hall of Records, Los Angeles, Calit.
536 Schaffner, J. V., Jr., Melrose Highlands, Mass.
537 Schalck, E. M., 1722 N. Mozart St., Chicago, Ill.
538 Scholl, E. E., Capitol Building, Austin, Texas.
539 Scott, W. M., Office of Markets, Department of Agriculture, Washington, D. C.
540 Scullen, H. A., Agricultural College, Corvallis, Ore.
541 Searls, E. L., Schaghticoke, N. Y.
542 Shaw, N. E., State Department of Agriculture, Columbus, Ohio.
543 Simmons, Perez, U. S., Bureau of Entomology, Washington, D. C.
544 Smith, Charles E., Experiment Station, Baton Rouge, La.
545 Smith, G. A., State Forester's Office, State House, Boston, Mass.
546 Smith, H. E., Randolph, Vt.
547 Smith, M. R., Fort Mill, S. C.
548 Smith, R. C., Agricultural College, Manhattan, Kans.
549 Smith, R. H., Twin Falls, Idaho.
550 Snapp, O. I., Bureau of Entomology, Fort Valley, Ga.
551 Snow, S. J., Address unknown.
552 Somes, M. P., Clinton, Miss.
553 Spangler, A. J., 838 Leydere St., Denver, Colo.
554 Speaker, H. J., Sandusky, Ohio.
555 Spencer, Herbert, West Raleigh, N. C.
556 Spooner, Charles, 1508 South 3d St., Charleston, Ill.
557 Spuler, Anthony, Agricultural Experiment Station, Pullman, Wash.
558 Stafford, E. W., Agricultural College, Miss.
559 Stage, H. H., 1608 Oak St., Pine Bluff, Ark.
560 Stahl, C. F., Citrus Experiment Station, Riverside, Calif.
561 Stear, J. R., 431 Philadelphia Ave., Chambersburg, Pa.
562 Stiles, C. F., Agricultural Experiment Station, Stillwater, Okla.
563 Stirling, Frank, State Plant Board, Gainesville, Fla.
564 Stockwell, C. W., Entomological Laboratory, Riverton, N. J.
565 Strand, A. L., 319 S. Black Ave., Bozeman, Mont.

566 Sullivan, K. C., Columbia, Mo.
567 Swain, A. F., 2045 Belmont Ave., Fresno, Calif.
568 Taft, L. R., East Lansing, Mich.
569 Talbert, T. J., Agricultural College, Manhattan, Kan.
570 Taylor, L. H., Board of Agriculture, Boston, Mass.
571 Thomas, F. L., Auburn, Ala.
572 Thomas, W. A., Chadbourn, N. C.
573 Thompson, B. G., 600 26th St., Sacramento, Calif.
574 Tillery, J. L., Concord, Tenn.
575 Tower, D. G., 195 Broadway, New York, N. Y.
576 Tower, W. V., Mayaguez, P. R.
577 Trimble, F. M., Camp Hill, Cumberland Co., Pa.
578 Tsou, Y. H., University of Nanking, Nanking, China.
579 Turner, C. F., Corn Borer Laboratory, Schenectady, N. Y.
580 Turner, W. B., 43 Tremont St., Boston, Mass.
581 Turner, W. F., Blue Ridge, Ga.
582 Uichanco, L. B., Bussey Institution, Forest Hills, Boston, Mass.
583 Underhill, G. W., Box 156, Chester, Va.
584 Van Duzee, E. P., Academy of Science, Golden Gate Park, San Francisco, Calif.
585 Vickery, R. K., 1220 Byron St., Palo Alto, Calif.
586 Wade, Joe S., U. S. Bureau of Entomology, Washington, D. C.
587 Wadley, F. M., R. F. D. 9, Rockford, Ill.
588 Wakeland, C. C., University of Idaho, Boise, Idaho.
589 Walkden, H. H., 126 S. Minneapolis Ave., Wichita, Kans.
590 Wallace, F. N., State Entomologist, Indianapolis, Ind.
591 Walter, E. V., Tempe, Ariz.
592 Warren, Don C., Valdosta, Ga.
593 Watts, H. R., Knoxville, Tenn.
594 Webber, R. T., U. S. Bureau of Entomology, Melrose Highlands, Mass.
595 Weed, C. M., State Normal School, Lowell, Mass.
596 Wehr, E. E., Star, Idaho.
597 Wehrle, L. P., Roberts Hall, Ithaca, N. Y.
598 Wellhouse, Walter, 307 Eddy St., Ithaca, N. Y.
599 Wells, R. W., Box 208, Dallas, Texas.
600 Whelan, Don B., Midland, Mich.
601 Whitcomb, W. D., Yakima, Wash.
602 White, W. H., College Park, Md.
603 Whitmarsh, R. D., Milwaukee, Wis.
604 Williams, C. B., 20 Slatey Road, Bikenhead, England.
605 Williams, W. R., Tallulah, La.
606 Williamson, Warren, 701 W. California St., Urbana, Ill.
607 Willson, R. B., Agricultural College, Miss.
608 Wiltberger, P. B., Address unknown.
609 Winchester, H. I., 964 Main St., Melrose Highlands, Mass.
610 Winslow, R. M., Vernon, B. C., Canada.
611 Wood, E. G., State College, Pullman, Wash.
612 Woodworth, H. E., College of Agriculture, Los Banos, P. I.
613 Wooldridge, Reginald, U. S. Bureau of Entomology, Melrose Highlands, Mass.
614 Worthley, L. H., 43 Tremont St., Boston, Mass.
615 Young, A. W., South Yarmouth, Mass.
616 Young, D. B., State Museum, Albany, N. Y.
617 Young, M. T., Tallulah, La.
618 Yuasa, Hachiro, Zoology Laboratory, University of Chicago, Chicago, Ill.

## FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Ballou, H. A., Imperial Department of Agriculture, Barbados, West Indies.
Berlese, Dr. Antonio, Reale Stazione di Entomologia, Agraria, Firenze, Italy.
Bordage, Edmond, Directeur de Musee, St. Denis, Reunion.
Brain, Charles K., Pretoria, South Africa.
Carpenter, Dr. George H., Royal College of Science, Dublin, Ireland.
Cholodkosky, Prof. Dr. N., Militar-Medicinische Akademie, Petrograd, Russia.
Collinge, W. E., 55 Newhall St., Birmingham, England.
Danysz, J., Laboratoire de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Deli, Sumatra.
Escherisch, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.
French, Charles, Department of Agriculture, Melbourne, Australia.
Froggatt, W. W., Department of Agriculture, Sydney, New South Wales.
Fuller, Claude, Department of Agriculture, Peitermaritzburg, Natal, South Africa.
Goding, F. W., Guayaquil, Ecuador, South America.
Grasby, W. C., 6 West Australian Chambers, Perth, West Australia.
Green, E. E., Way's End, Beach Ave., Camberley, Surry, England.
Herrera, A. L., Director de Estudios, Bibliogicas, Secretaria de Agricultura y Formento, Mexico, D. F. Mexico.
Hill, Gerald F., Townsville, North Queensland.
Horvath, Dr. G., Musee Nationale Hongroise, Budapest, Hungary.
Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Jack, Rupert W., Salisbury, Rhodesia, South Africa.
Johnson, Thomas H., University of Brisbane, Queensland, Australia.
Kulagin, Nikolai M., Landwirtschaftliches, Institut, Petrooskoje, Moskow, Russia.
Kuwana, S. I., Imperial Agricultural Experiment Station, Yokohama, Japan.
Lea, A. M., National Museum, Adelaide, South Australia.
Lounsbury, Charles P., Department of Agriculture, Pretoria, Transvaal, South Africa.
Mally, C. W., Department of Agriculture, Cape Town, South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.
Mokshetsky, Sigismond, Musee d'Histoire Naturelle, Simferopol, Crimea, Russia.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales
Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Waldemar, Station Entomologique, Rue de Boulevard, No. 9, Kiev, Russia.
Reed, Charles S., Mendoza, Argentine Republic, South America.
Ritzema Bos, Dr. J., Agricultural College, Wageningen, Netherlands.
Rosenfeld, A. H., Ingenio Santa Ana, F. C. N. O. A., Tucuman Argentina.
Sajo, Prof. Karl, Godollo-Veresegyhaz, Hungary
Schoyen, Prof. W. M., Zoölogical Museum, Christiania, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Shipley, Prof. Arthur E., Christ's College, Cambridge, England.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Theobald, Frederick V., Wye Court, Wye Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tillyard, R. J., Cawthron Institute of Scientific Research, Nelson, New Zealand.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.
Urich, F. W., Victoria Institute, Port of Spain, Trinidad, West Indies.
Vermorel, V., Station Viticole, Villefranche, Rhone, France.

# JOURNAL

OF

# ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 14 FEBRUARY, 1921 No. 1


## Proceedings of the Thirty-Third Annual Meeting of the American Association of Economic Entomologists

The thirty-third annual meeting of the American Association of Economic Entomologists was held in Kent 20, University of Chicago, December 29 to 31, 1920.

The meeting was called to order by President Wilmon Newell, at 10.10 a. m., December 29. The annual reports and routine business of the opening session was transacted and two papers were presented at this session. At the afternoon session, the annual address of the President was delivered, which was followed by general discussion and program of interesting papers. On the same evening, the Section on Apiculture held its meeting, which was largely attended and was of unusual interest. Meetings of the general association were continued on Thursday morning, December 30, and in the afternoon the time was given over to the Section on Horticultural Inspection.

On Thursday evening, a dinner was held at the Sherman Hotel, at which one hundred entomologists were present. President Newell introduced Professor W. C. O'Kane to preside at the close of the dinner and representatives from most of the entomological societies in the United States and Canada were called upon to respond. This occasion was greatly enjoyed by all present.

On Friday morning, December 31st, a joint session was held with the American Phytopathological Society in Mandel Hall, University of Chicago.

The final session of the association with reading of papers and transaction of final business, was called to order at 1.30 p. m., Friday afternoon.

The business proceedings form Part I of this report, and the addresses, papers, and discussions Part II.

The proceedings of the Sections on Apiculture and Horticultural Inspection will be prepared by the sectional secretaries and published as a part of this report.

## PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President Newell, at 10.10 a. m., Wednesday, December 29, 1920. About 160 members and visitors attended the sessions. The following were present:

George G. Ainslie, R. R. 9, Knoxville, Tenn.
J. M. Aldrich, Washington, D. C.
R. H. Allen, Boston, Mass.
William J. Baerg, Fayetteville, Ark.
E. D. Ball, Ames, Iowa.
William Barnes, Decatur, Ill.
G. M. Bentley, Knoxville, Tenn.
S. W. Bilsing, College Station, Texas.
R. W. Braucher, Chicago, Ill.
W. H. Brittain, Truro, N. S.
Luther Brown, Gulfport, Miss.
C. T. Brues, Boston, Mass.
A. F. Burgess, Melrose Highlands, Mass.
William B. Cartwright, Centralia, Ill.
W. L. Chandler, East Lansing, Mich.
R. N. Chapman, Minneapolis, Minn.
E. C. Cotton, Columbus, Ohio.
J. J. Davis, LaFayette, Ind.
George A. Dean, Manhattan, Kan.
Dwight M. De Long, Harrisburg, Pa.
H. F. Dietz, Indianapolis, Ind.
Carl J. Drake, Syracuse, N. Y.
J. E. Dudley, Jr., Madison, Wis.
J. R. Eyer, State College, Pa.
H. L. Fackler, Knoxville, Tenn.
E. P. Felt, Albany, N. Y.
F. A. Fenton, Ames, Iowa.
C. K. Fisher, Wichita, Kan.
W. P. Flint, Urbana, Ill.
C. L. Fluke, Jr., Madison, Wis.
S. A. Forbes, Urbana, Ill.
Anson L. Ford, Brookings, S. D.
S. B. Fracker, Madison, Wis.
Arthur Gibson Ottawa Can.
H. A. Gossard, Wooster, Ohio.
J. E. Graf, Biloxi, Miss.
Samuel A. Graham, St. Paul, Minn.
Thomas L. Guyton, Harrisburg, Pa.
Charles H. Hadley, Jr., Riverton, N. J,
R. W. Harned, Agricultural College. Miss.
Albert Hartzell, Ames, Iowa.
Leonard Haseman, Columbia, Mo.
Kenneth Hawkins, Watertown, Wis.
T. J. Headlee, New Brunswick, N. J.
Glenn W. Herrick, Ithaca, N. Y.
W. E. Hinds, Auburn, Ala.
H. E. Hodgkiss, State College, Pa.
William E. Hoffmann, Lawrence, Kans.
J. R. Horton, Wichita, Kan.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
S. J. Hunter, Lawrence, Kan.
H. E. Jaques, Mt. Pleasant, Iowa.
E. G. Kelly, Manhattan, Kan.
H. H. Kimball, Agricultural College, Miss.
H. H. Knight, St. Paul, Minn.
E. J. Kraus, Madison, Wis.
W. H. Larrimer, West LaFayette, In.
Stewart Lockwood, Agricultural College, N. D.
Q. S. Lowry, Canton, Mass.
S. Marcovitch, Knoxville, Tenn.
C. L. Marlatt, Washington, D. C.
J. W. McColloch, Manhattan, Kan.
A. L. Melander, Pullman, Wash.
C. L. Metcalf, Columbus, Ohio.
Z. P. Metcalf, West Raleigh, N. C.
J. H. Montgomery, Gainesville, Fla.
William Moore, St. Paul, Minn.
Henry Ness, Ames, Iowa.
Wilmon Newell, Gainesville, Fla.
F. M. O'Bryne, Gainesville, Fla.
W. C. O'Kane, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
Raymond C. Osburn, Columbus, Ohio.

J. H. Pearmann, Davenport, Iowa.
F. B. Paddock, Ames, Iowa.
H. R. Painter, West LaFayette, Ind.
Wallace Park, Ames, Iowa.
. H. Parks, Columbus, Ohio.
P. J. Parrott, Geneva, N. Y.
N. L. Partridge, E. Lansing, Mich.
L. M. Peairs, Morgantown, W. Va.
G. W. Peake, St. Paul, Minn.
F. C. Pellett, Hamilton, Ill.
Alvah Peterson, New Brunswick, N. J.
C. H. Popenoe, Washington, D. C.
A. L. Quaintance, Washington, D. C.
E. R. Root, Medina, Ohio.
A. H. Rosenfeld, Tucuman, Argentina.
O. W. Rosewall, Baton Rouge, La.
A. G. Ruggles, St. Paul, Minn.
V. I. Safro, Louisville, Ky.
J. G. Sanders, Harrisburg, Pa.
E. R. Sasscer, Washington, D. C.
A. F. Satterthwait, Webster Groves, Mo.
H. C. Severin, Brookings, S. D.
V. E. Shelford, Urbana, Ill.
F. L. Simanton, Benton Harbor, Mich.
M. P. Somes, Clinton, Miss.
Frank Stirling, Gainesville, Fla.
K. C. Sullivan, Columbia, Mo.
J. M. Swaine, Ottawa, Can.
M. H. Swenk, Lincoln, Neb.
O. H. Swezey, Honolulu, H. T.
L. R. Taft, East Lansing, Mich.
M. C. Tanquary, College Station, Tex.
E. P. Taylor, Tucson, Ariz.
C. F. Turner, Schenectady, N. Y.
L. B. Uichanco, Forest Hills, Mass.
F. M. Wadley, Rockford, Ill.
Claude Wakeland, Boise, Idaho.
F. N. Wallace, Indianapolis, Ind.
W. R. Walton, Washington, D. C.
R. L. Webster, Ithaca, N. Y.
W. M. Wheeler, Boston, Mass.
R. D. Whitmarsh, Milwaukee, Wis.
H. F. Wilson, Madison, Wis.
H. Yuasa, Chicago, Ill.

President Wilmon Newell: The meeting will please come to order. We will now hear the report of the Secretary.

## REPORT OF THE SECRETARY

At the St. Louis meeting, the total membership of the association was 566, as follows: Active, 216; associate, 303; foreign, 47. At that meeting 51 associate members were elected and one re-instated, and 31 were transferred from the associate to the active roll. Two associate members resigned during the year, and three active and nine associate members have been dropped for non-payment of dues. Two associate members have been dropped, they having paid no dues since being elected to membership, and two active members have died during the year. Three foreign members were elected and three were reported as having died.

The present membership is 242 actives, 311 associate, and 47 foreign, making a total of 600, a net gain of 34 for the year.

Early in March the members of the association were shocked to learn of the sudden death on February 29 of Dr. C. Gordon Hewitt, Entomologist of the Dominion of Canada. He was a past president of the association and since the time of his appointment as Dominion Entomologist, had been a regular attendant at the annual meetings. His pleasing personality as well as his ability and zeal as an entomologist, had endeared him to all his co-workers in entomology. While his loss to those on this side of the border is most keenly felt, the loss to Canada is much more severe. During the time he held the office of Dominion Entomologist, it continually increased in influence and prestige. The scope of the work was broadened and the foundation laid for increased development of the entomological field throughout the Dominion. No greater word can be said of any man when he lays down the duties of his office than that his work has been well done. As entomologists we are proud of his splendid achievements wrought through a few short years.

Professor W. R. McConnell died on June 23 at Carlisle, Pa. He was an active member of the association and greatly admired and respected by those who were

fortunate enough to know him. From a Professorship at the Pennsylvania State College, he accepted an appointment with the Bureau of Entomology, specializing on cereal and forage insects, particularly on the parasites of some of the most destructive pests.

He was a hard and conscientious worker and was conducting investigations of great promise, and it was with deep regret that the association was called upon to mourn his loss.

The death of three foreign members has been reported to the Secretary during the year.

Fred Enock died in July, 1916, at London, England; Richard Helms, North Sydney, New South Wales, and N. Kourdumoff, Opytnoe Pole, Poltava, Russia. The exact date of the death of the last two is not definitely known. Mr. Kourdumoff visited this country some years ago and proved to be a young man of great promise. After his return to Russia, he acted for several years as a collaborator of the Bureau of Entomology and endeavored to secure information that might be of value to this country concerning the gipsy moth and other insects. He extended every aid possible in this respect and enjoyed the friendship and confidence of all American entomologists who knew him. He was said to have died while serving in the Russian Army.

The Pacific Slope Branch held its annual meeting June 17–19, 1920, at Seattle, Washington. It was well attended and many papers of interest were presented.

At the last annual meeting the association voted to discontinue the use of numbered buttons. Since that time, a number of members, particularly those who do not attend the meetings frequently and have not become well acquainted, have strongly urged that some means of identification be adopted at the meeting to enable new members to get in touch promptly with others whom they wish to meet. As a result of this sentiment and by direction of the executive committee, the Secretary is furnishing name tags to be used in the coat lapel of members at the Chicago meeting.

## Journal of Economic Entomology

During the past year, the cost of printing the Journal has advanced 25 per cent. over the figures for the preceding years. By strict economy and by holding the number of printed pages at about the same number as for the past two years, it has been possible to carry through the publication without increasing the subscription price. This could not have been done from receipts from subscriptions alone, and there would have been a slight deficit if a large number of back numbers and used cuts had not been sold. These sales amounted to $394.65, and this has enabled the Journal to finish the year with approximately the same balance as at this time last year.

Our present publishers state that they have printed the Journal at a financial loss during the past year, and that beginning January 1st, it will be necessary to increase the price of printing 50 per cent. Efforts are being made to secure better rates for printing, as it is evident that the same number of pages cannot be published next year at these rates without serious loss to the association. It is evident under these conditions that an increase of at least $1.50 per volume on the Journal, based on our present subscription lists, would be necessary in order to meet the increased cost, and this change of rate cannot be made before January 1st, 1922. Unless some means can be found of reducing the cost of printing very materially, it will be necessary to reduce the size of the publication or find additional funds to finance it during the coming year. For the information of our members the following table is submitted, showing the number of active and associate members of the association, circulation of the Journal, number of pages printed, average cost per page which

includes part of the expense for mailing, and balance in the JOURNAL fund after deducting loans, from 1915 to 1920 inclusive

| Year | Members<br>Active and Associate | Circulation | Pages | Cost Per Page | Balance | Loan |
|---|---|---|---|---|---|---|
| 1915 | 402 | 764 | 566 | \$2.24 | \$755.02 | |
| 1916 | 416 | 753 | 580 | 2.62 | 646.87 | |
| 1917 | 451 | 772 | 572 | 3.24 | 189.27 | |
| 1918 | 507 | 757 | 494 | 3.40 | −105.89 | \$200.00 |
| 1919 | 519 | 851 | 478 | 3.65 | 83.23 | 310.00 |
| 1920 | 552 | 844 | 488 | 4.79 | 385.10 | |

**The Journal is indebted to the association for funds advanced, \$350.00.**

In 1920, 42 active and associate members and 41 foreign members did not subscribe to the JOURNAL. Since 1915, the cost of publishing the JOURNAL has increased from \$2.24 to \$4.79 per net page, amounting to 114 per cent. Until January 1st, 1920, no increase in subscription rates was made, but on that date, \$1.00 per volume was added to the rate. This is an increase of 66⅔ per cent. for members, and 40 per cent. for non-members. The increase in costs of production has been taken up by decreasing the size of the JOURNAL and by borrowing funds from the association and by loan of \$60 by members at the Baltimore meeting, which has been credited to their subscription accounts and is gradually being paid back in that way. With the increase in membership of the association, the pressure for publishing articles by the members has greatly increased. This has been intensified during the past year on account of the extreme difficulty in inducing local, state, or Federal institutions to publish the results of many investigations that have been carried on.

Suggestions have been received that the stenographic report of the annual meeting be dispensed with and that no discussions be printed in the JOURNAL. On the basis of the report for 1920, about 30 pages of printed matter would be eliminated by following this plan. The elimination from the February issue of the JOURNAL of the organization, list of meetings and members, would also save considerable expense.

The judgment of the members is desired as to their wishes in this respect.

### INDEX TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY I

During the past year, a considerable number of copies of this Index have been sold, and it has been possible to return to the association treasury \$100 which clears up the indebtedness of the Index to the association. A small balance remains in the treasury and there are now on hand 231 bound and 400 unbound copies which are available for sale.

It is deemed advisable to increase the price of this Index to \$6.00 a copy so as to make it uniform with the sale price of the new Index, which is about to be issued. These prices are to be effective January 1. It is recommended that all funds not needed for postage, insurance, etc., in connection with Index I, be transferred to the fund that is being used for publishing Index II.

### INDEX TO LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY II

At the last annual meeting, the association voted that the editorial board of the JOURNAL OF ECONOMIC ENTOMOLOGY should take charge of the publication of Index II.

The manuscript for this Index was prepared by Miss Mabel Colcord, Librarian of the U. S. Bureau of Entomology, and numerous assistants and experts in that Bureau. The financial arrangements relative to publishing the Index were left to the Secretary and the editorial work to the Editor of the JOURNAL. Estimates

secured in the early spring indicated that the price of publication would far exceed the amount of the estimates made in the report submitted at the last annual meeting. This was due to the increased cost of printing and because the number of pages greatly exceeded the estimates. It was not until June that figures were received from any publisher that were low enough to warrant the association in attempting to finance this publication.

Immediately following the receipt of bids that seemed to be within our means, circulars were sent to all members of the association, asking for advance prepaid subscriptions at the rate of $5.00 per copy. The response was rather meagre and a second request was made in July which brought slightly better results. Conditions were such at the time that it was evident that the association could not hope to publish this book without securing financial aid, and with the approval of the editorial board, the executive committee and the committee on policy were asked to authorize the association to borrow $1500 to finance the publication. This request was made August 13, but final action was not secured from these two committees until October.

In order to neglect no possible opportunity for having this book published, the editor made request that it be issued by the U. S. Department of Agriculture. Owing to the conditions of the publication fund and the nature of the matter to be published, it was impossible for the Department to undertake the work, and your Secretary immediately endeavored to raise the necessary money to publish the Index by soliciting loans of $25 or more from various members.

On this date, December 1, 1920, 145 members have subscribed and paid for 161 copies of the Colcord Index, and 29 loans of $25 each have been secured from 26 members. In addition to this, 58 orders for this Index have been received that cannot be paid for until the book has been delivered. In anticipation that whatever additional funds are necessary can be raised during the meeting, the contract for printing has been awarded and the Index should be ready for mailing in February.

ASSOCIATION STATEMENT

| | | |
|---|---|---|
| Balance in Treasury, December 8, 1919 | | $ 803.48 |
| By amount received from dues, 1920 | | 610.50 |
| By amount received from interest in Malden National Bank | | 22.49 |
| By amount received from interest, Melrose Savings Bank | | 7.81 |
| By amount received from interest $100 Liberty Bond | | 4.25 |
| By amount received from Index I fund | | 100.00 |
| By amount received from JOURNAL fund | | 100.00 |
| Paid stenographic report of 1919 meeting | $ 91.58 | |
| Buttons, 1919 meeting | 11.24 | |
| Postage | 67.86 | |
| Printing programs, etc | 111.76 | |
| Stationery | 59.65 | |
| Tags | 3.50 | |
| Discount on checks | 5.50 | |
| Returned check | 3.50 | |
| Telegraph and express | 12.80 | |
| Expenses of Committee on National Museum (Postage) | 5.74 | |
| Expenses of Pacific Slope Branch | 8.91 | |
| Clerical work, Secretary's office | 40.00 | |
| One-half salary of Secretary | 50.00 | |
| | $ 472.04 | |
| Balance, December 1, 1920 | 1,176.49 | |
| | $1,648.53 | $1,648.53 |

| | | |
|---|---|---|
| Balance deposited as follows: | | |
| Melrose Savings Bank | $ 179.83 | |
| Malden National Bank | 996.66 | |

JOURNAL STATEMENT

| | | |
|---|---|---|
| Balance in Treasury, December 8, 1919 | | $ 393.32 |
| By amount received from subscriptions, advertising, etc. | | 2,943.99 |
| By amount received from Malden National Bank (interest) | | 15.04 |
| Paid for postage | $ 79.40 | |
| Paid for insurance | 17.00 | |
| Paid for printing | 2,335.45 | |
| Paid for half-tones | 125.23 | |
| Return on subscriptions | 9.12 | |
| Exchange on checks | 17.05 | |
| Returned checks | 9.00 | |
| Transfer to Association fund | 100.00 | |
| Salary, Editor | 100.00 | |
| Clerical work, Editor's office | 75.00 | |
| One-half salary of Secretary | 50.00 | |
| Clerical work, Secretary's office | 50.00 | |
| | $2,967.25 | |
| Balance, December 1, 1920 | 385.10 | |
| | $3,352.35 | $3,352.35 |
| Balance deposited in Malden, Mass., National Bank | $ 385.10 | |
| The JOURNAL owes the Association account | | $ 350.00 |

INDEX I STATEMENT

| | | |
|---|---|---|
| Balance in Treasury, December 8, 1919 | | $ 25.72 |
| By amount received from sales to December 1, 1920 | | 182.45 |
| By amount received from Index II postage (advanced) | | 22.50 |
| By amount received from Index II Printing (advanced) | | 5.50 |
| Paid for Printing | $ 5.50 | |
| Paid for Postage | 38.83 | |
| Paid for insurance | 17.00 | |
| Transfer to Association fund | 100.00 | |
| | $ 161.33 | |
| Balance, December 1, 1920 | 74.84 | |
| | $ 236.17 | $ 236.17 |
| Balance deposited in Malden, Mass., National Bank | $ 74.84 | |

INDEX II STATEMENT

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| Received from advance subscriptions | | $ 807.50 |
| Paid for printing and postage | $ 31.00 | |
| Paid for express | .35 | |
| Paid for returned checks | 10.00 | |
| | $ 41.35 | |
| Balance, December 1, 1920 | 766.15 | |
| | $ 807.50 | $807.50 |
| Deposited in Malden, Mass., National Bank | $ 766.15 | |

SUMMARY

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|---|---|
| Balance on Index I account | $ 74.84 |
| Balance on Index II account | 766.15 |
| Balance on JOURNAL account | 385.10 |
| Balance on association account | 1,176.49 |
| One 4¼ per cent. Liberty Bond | 100.00 |
| | $2,502.58 |

RECOMMENDATIONS

It is recommended that all but a small balance for mailing that remains in the Index I fund be transferred to the Index II fund; that not to exceed $700 be transferred from the association fund to the Index II fund—this amount to be repaid as soon as sales of this book furnish the necessary funds; that the Editorial Board "of the JOURNAL" be authorized to increase the price beginning January 1st, 1922, if conditions during the first half of the coming year make such an increase necessary; that the association take definite action concerning the approximate number of pages that should be published annually in the JOURNAL, and if it is desired to keep the JOURNAL at its present size, some adequate means be found to meet the cost during the coming year.

Respectfully submitted,
A. F. BURGESS, *Secretary*

Voted that the recommendations in the report be referred to the executive committee and that the financial part of the report be referred to the auditing committee.

PRESIDENT WILMON NEWELL: I will now read the report of the Executive Committee.

## REPORT OF THE EXECUTIVE COMMITTEE

The Executive Committee has not been able to meet during the year but has considered and passed upon a number of matters by correspondence.

### FINANCIAL SUPPORT OF IMPORTANT PROJECTS

During the early part of the year there appeared serious danger of appropriations for a number of important lines of entomological work, including the gipsy moth, European corn borer and pink bollworm projects, being severely reduced and to such an extent as to incur serious risk of these pests getting entirely beyond control. This situation was called to the attention of a number of our active members by your President, with the result that information bearing on these projects and their respective merits was placed in the hands of members of Congress. The amounts for the various lines of entomological work were in most instances restored to the figures requested by the Bureau of Entomology. In this connection it should be said that Chairman O'Kane, of the Committee on Policy, did efficient work in Washington in behalf of appropriations for entomological projects, most of which are national in scope.

### COMMITTEE ON ENTOMOLOGY, NATIONAL RESEARCH COUNCIL

Early in the year the National Research Council decided to appoint, as its Committee on Entomology, Division of Biology and Agriculture, the members of this

Association's Committee on Policy, with one member at large. To fill the latter position your President, with approval of the Executive Committee, appointed Dr. A. L. Quaintance of the Bureau of Entomology.

### Crop Protection Institute

At a conference of insecticide manufacturers, plant pathologists and entomologists, arranged for by the National Research Council and held at Rochester, New York, June 23, our Association was represented by Messrs. W. C. O'Kane, P. J. Parrott, E. P. Felt and J. G. Sanders. At this conference preliminary plans were made for the formation of the "Crop Protection Institute". Organization of the Institute was perfected at a meeting held in Washington September 28th, attended by the President and several members of our Committee on Policy, as well as other members of our association, representatives of the American Phytopathological Society and of the manufacturers of insecticides and spraying machinery. The constitution adopted by the Plant Protection Institute provided for a board of trustees composed of 13 members, consisting of three representatives from the American Association of Economic Entomologists, three from the American Phytopathological Society, two from the Association of Official Agricultural Chemists, one from the National Research Council, three from the Manufacturers of Insecticides and Fungicides and one from the Manufacturers of Allied Lines. As representatives of our Association, to serve in this capacity until the next annual meeting, your President appointed Messrs. P. J. Parrott, J. G. Sanders and W. C. O'Kane. These appointments were approved by the Executive Committee.

### Regional Branches

The Executive Committee has given careful thought to the question of encouraging the establishment of regional branches of our Association. On this question, which is essentially one of policy, the members of the Committee have held somewhat diverse opinions and as it is evidently a matter of keen interest to the entire membership the Executive Committee has taken no action on it. Further reference to this question will doubtless be contained in the report of the Committee on Policy.

### Extension

On February 18th your President, at the suggestion of the Subcommittee on Organization and with the approval of the Executive Committee, appointed Dr. L. O. Howard as representative of our Association to investigate the feasibility of encouraging the formation of an association of economic entomologists in Europe, with a possible view to the ultimate organization of an international association. Dr. Howard discharged in a highly satisfactory manner the task entrusted to him and has submitted a rather full report on this question to the Committeee on Policy.

### Index to Economic Entomology

In October the Executive Committee gave its approval to the borrowing of $1,500 for the purpose of financing the new Index to Economic Entomology, it appearing from the information at hand that this amount would easily be repaid by proceeds from the sale of the index but that the actual publication could not be handled without this amount of actual cash being available.

### Identification Buttons at Annual Meetings

At our last annual meeting the Association voted to dispense with the use of numbered identification buttons at our annual meetings. It is the opinion of your

Executive Committee that this action was somewhat hasty and was taken without the members having given thoughtful consideration to the advantages derived from any method whereby the members of our Association quickly become acquainted and thereby derive the maximum of benefit from our meetings. The Committee therefore recommends that the custom of having numbered buttons, with a corresponding list of the members for reference, be renewed or that some plan, accomplishing the same purpose, be approved of by the Association.

WILMON NEWELL,
H. A. GOSSARD,
E. M. EHRHORN,
J. G. SANDERS,
F. B. PADDOCK,
A. F. BURGESS,
*Executive Committee*

By vote of the association the report was accepted and the recommendations adopted.

PRESIDENT WILMON NEWELL: The next is the report of the committee on policy.

This report was read by the chairman, Mr. W. C. O'Kane, and by vote of the association, was made the special order of business at 11 a. m., the following day. It was voted to have mimeographed copies made of the recommendations contained in this report for the use of members.

PRESIDENT WILMON NEWELL: The report of the Representative to the National Research Council will be given by Mr. P. J. Parrott.

## REPORT OF REPRESENTATIVE TO THE NATIONAL RESEARCH COUNCIL

As the representative of the American Association of Economic Entomologists, I have attended all meetings of the Division of Biology and Agriculture of the National Research Council except one, which was held at the time of an extended visit to the Pacific Coast states.

In accordance with instructions, the Committee of Policy of the Association, with one member at large, was designated as the Committee of Entomology of the Division of Biology and Agriculture. Dr. A. L. Quaintance was subsequently appointed as the member at large, which insures a resident representative at Washington.

The resolution regarding entomological collections in the National Museum was adopted, and assistance offered.

There was also brought to the attention of the Division, the instructions of the Committee of Policy, for a conference with representatives of several chemical companies, to consider financial support for research and experimentation. Dr. Howe, Chairman of the Division of Research Extension, was authorized to cooperate with committees appointed by the entomologists and phytopathologists and to represent the Council in negotiations with the industrial concerns. Subsequent activities on this project, which finally culminated in the establishment of the Crop Protection Institute, have been mentioned in the JOURNAL OF ECONOMIC ENTOMOLOGY, and reported with considerable detail in circulars distributed by the National Research Council and the Crop Protection Institute.

FINANCIAL STATEMENT, FOR 1920

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| Balance of cash on hand, Dec. 24, 1919 | $58.93 |
| Receipts during the year 1920 (none) | 00.00 |
| Total receipts for 1920 | $58.93 |
| Disbursements: | |
| By stenographic service, Dec. 24, 1919 to May 15, 1920, total of 140 letters at 10 cents (V. 1) | $14.00 |
| By stenographic service, May 15 to Dec. 31, 1920 (estimated correspondence 140 letters, (Voucher No. 2) | $14.00 |
| By postage paid, 280 letters (Voucher No. 3) | 5.60 |
| By envelopes (Voucher No. 4) | 3.00 |
| Total | $36.60 |
| Balance cash on hand, Dec. 27, 1920 (check to cover) | 22.33 |
| | $58.93 |

Respectfully submitted,

W. E. HINDS,
*In Charge*

Voted that the report be accepted; that Dr. Hinds be cordially thanked; that the financial part be referred to the auditing committee, and that the balance on hand be turned into the treasury of the association with the understanding that any members who have claims on that balance for unfulfilled obligations, may be re-imbursed on the proper presentation of these claims to the Secretary of the association.

MR. W. E. HINDS: I would like to make a brief statement in regard to the occurrence of the Mexican Bean Beetle in the Southern states.

This insect has become established in the vicinity of Birmingham, Ala., the first information as to serious injury being reported about the first of July, 1920. Work has been carried on to determine the distribution and possible spread of the species in the Eastern United States by the southern entomologists and the matter has been considered by the Federal Horticultural Board.

The establishment of this insect seems to be a serious national entomological problem. It has taken on new food plants and has more generations in the South than in the West. Apparently it will spread throughout the eastern United States wherever beans, cowpeas, and soy beans are grown in large quantities. These crops are of fundamental importance for food, forage, and for the renewal of soil fertility.

The legislature of the State of Alabama was in special session in September and was asked to appropriate $250,000 as a start toward a campaign for exterminating the pest in the eastern part of the country. The bill failed to receive a two-thirds vote in the legislature, this being

necessary to enact such a law at a special session. We are therefore without resources so far as the state of Alabama is concerned.

The Bureau of Entomology and the Federal Horticultural Board have been so impressed with the importance of the problem that a supplemental item, amounting to $150,000, has been added to the Agricultural Appropriation Bill to meet the emergency. This is to be expended for control, quarantine, and experimental work. I hope the members of this association will use all the influence possible in this emergency and I believe it will be helpful if many of the members will take this matter up favorably with Congressmen who are on the agricultural committee and urge them to support this item.

Mr. Z. P. Metcalf presented a statement as a member of the committee on the preservation of natural resources of the Ecological Society of America, covering the preservation of wild life, and stated that it was the belief of the committee that all organizations interested in natural history should support this committee.

The matter was referred to the committee on resolutions for later report.

On Thursday morning at 11 a. m., the report of the committee on policy was taken up for consideration. Each recommendation was read separately and after a number of amendments had been made, the report was adopted as follows:

## REPORT OF THE COMMITTEE ON POLICY

### Organization

The Committee on Policy organized for the year 1920 with the following subcommittees:

Education, Dr. Osborn, chairman, Dr. Ball and Mr. Burgess.
Insect Control, Dr. Felt, chairman, Mr. Sanders and Prof. O'Kane.
Organization, Mr. Sanders, chairman, Prof. O'Kane, and Mr. Newell.
Research, Dr. Ball, chairman, Mr. Parrott and Dr. Osborn.
Publications, Mr. Burgess, chairman, Dr. Felt and Mr. Pierce.

### Cooperation with European Entomologists

Early in the year the committee, acting with the officers of the Association, proposed to Dr. L. O. Howard that he approach European entomologists on the occasion of his visit to Europe in the early summer, to ascertain the possibilities in the way of forming, in Europe, an Association of Economic Entomologists along the same lines as our Association in this country. This commission was accepted by Dr. Howard. In conference with European entomologists, however, he found that conditions were not favorable at the present time for carrying out the project, partly because of the after-effects of the war, partly because of the lack of a common language and for other reasons.

Dr. Howard's report is as follows:

On February 14th, last, you wrote me, in your capacity as Chairman of the Committee on Policy of the American Association of Economic Entomologists, formally transmitting through me to European Entomologists the greetings of the A. A. E. E. and the adherence of the Committee on Policy to the proposal that there should be formed an European association of Economic Entomologists.

My report on this matter has been delayed from a misunderstanding, since it first appeared to me that I was to make a report direct to the Association. I see now that I should report to your Committee.

I endeavored to fulfill my commission in a satisfactory way and talked with a number of prominent economic entomologists during my visit abroad in England, France, Italy and Brussels. All of the men consulted were inclined to think that, while the idea might seem feasible enough to men in the United States, and that while theoretically it would be a very good scheme, there are nevertheless so many practical obstacles that the idea cannot be considered at the present time.

The initial difficulty is the one of language. Each country, moreover, has to a great extent its own problems. The financial condition of Europe at present is such as to be extremely unfavorable towards any international institution which requires the payment of dues. Moreover, the allies wish to have nothing to do with the Germanic countries. The exchange of publications between the different countries is already very intimate, and there seems to be no necessity whatever for the founding of an organ of publication like the JOURNAL OF ECONOMIC ENTOMOLOGY.

Other lesser matters were brought out in the course of my conferences, such as the striking disagreement between the two schools of economic entomologists in Italy, and other more or less temporary matters which interfere at present but which may not last for many years. The French entomologists are already on terms of intimate cooperation with the Italian men, but desire closer cooperation with the Imperial Bureau of Entomology of Great Britain.

The general opinion, however, was unanimous, and I myself agree with the soundness of the general conclusion. I recommend that the Committee wait for a more favorable time when the suggestion may be renewed.

## FEDERAL APPROPRIATIONS

In the last week of February members of the Committee took part in a conference in Washington relative to Federal appropriations for the work of the Bureau of Entomology and of the Federal Horticultural Board. The chairman of the committee appeared before the Committee on Agriculture of the United States Senate, which had before it the agricultural appropriation bill. The measure as passed by the House provided inadequate appropriations for important investigations and control measures and no appropriation at all for the European Corn Borer. The senate committee later increased these items and provided the sum of $500,000 for the European Corn Borer.

The bill then went to Conference Committee. The chairman of the Committee on Policy, on invitation from certain members of Congress, again went to Washington the first week in April and discussed appropriation matters with members of the Conference Committee.

The appropriations for these several activities as finally passed provided larger sums than originally allowed by the House, but smaller sums than inserted by the Senate.

## COOPERATION WITH THE NATIONAL RESEARCH COUNCIL

By vote of the Association at the St. Louis meeting, the proposal of the National Research Council, urging our Association to cooperate with the Council, was referred to the Committee on Policy, with power to act.

The Committee on Policy met at Albany, N. Y., April 19, with the following members present: Messrs. Parrott, Felt, Sanders, Burgess and O'Kane. At this meeting Mr. Parrott, representing our Association on the National Research Council,

reported that the Council proposed to set up a Committee on Entomology within the Division of Biology and Agriculture. In the case of the American Phytopathological Society, the Council had already designated the Advisory Board of the American Phytopathological Society as a Committee on Plant Pathology of the Council. It was voted to instruct Mr. Parrott to suggest to the Council that the Committee on Policy, with one member added, be designated as the Committee on Entomology of the Council.

It was voted further to instruct Mr. Parrott to recommend to the Council that it suggest to manufacturers of insecticides, fungicides and allied products that an organization be effected whereby, through joint action, funds might be made available for suitable projects in entomology and in plant pathology.

June 23, four members of the Committee on Policy, Messrs. Parrott, Felt, Sanders, and O'Kane took part in a conference in Rochester, N. Y., at which preliminary plans were adopted for an organization of entomologists, plant pathologists and the manufacturers of insecticides, fungicides and allied products, this organization to be brought about under the auspices of the National Research Council, and to be known as the Plant Protection Institute. At this conference a preliminary draft of a constitution and by-laws was drawn up and the general plan of the proposed Institute was adopted, subject to revision and ratification at a later meeting.

A further meeting was called at Washington, Tuesday, Sept. 28. The Committee on Policy met the preceding evening, with the following members present: Messrs. Newell, Ball, Sanders, Parrott and O'Kane. By invitation Dr. Quaintance, also, was present, as the additional member of our Association designated to serve on the Committee on Entomology of the National Research Council. The proposed plan of work of the Plant Protection Institute was studied in detail and certain changes were agreed on to be proposed the following day.

The following day a number of entomologists and plant pathologists met with a group of manufacturers in the offices of the National Research Council and completed organization of the Crop Protection Institute. In the organization as finally adopted control of the Institute is exclusively in a board of trustees of thirteen members, nine of whom are scientists who must be without commercial affiliations. Three of the nine are entomologists, three are plant pathologists, two are agricultural chemists and one is designated by the National Research Council. The industrial members choose four trustees, three of whom represent the manufacturers of insecticides and fungicides, and one represents the manufacturers of allied products. A temporary selection of the entomological members was made by the executive committee of the Association, pending action by the Association at the annual meeting at Chicago.

In assisting thus in the organization of the Crop Protection Institute the members of the Committee on Policy have not sought to bind the Association, as such, to any further measure of cooperation than appeared to be implied in the vote of the Association in the St. Louis meeting, in which the Committee was instructed to proceeed in the cooperative measures proposed by the National Research Council. It has appeared to the Committee clearly desirable to take advantage of the opportunity for helping to organize the proposed Institute along lines giving proper recognition to the profession of entomology and at the same time to help to shape the activities of the Institute in such fashion as to avoid conflict with existing agencies or duplication of existing lines of effort.

At the basis of the plan of organization of the Crop Protection Institute is a clear recognition of the authority, scope and influence of the American Association of Economic Entomologists in all activities of the Institute that relate to entomology.

At a meeting of the trustees of the Institute, held at New York City December 8, a resolution was adopted providing that in any projects relating to entomology the trustees of the Institute will seek the counsel of the Committee on Policy of the American Association of Economic Entomologists.

### State Quarantine Regulations

At a meeting of the Committee held April 19 at Albany, N. Y., it was voted to send to all state quarantine officers a recommendation to the effect that they modify existing state quarantines relating to the European Corn Borer in such manner as to make state regulations uniform and bring them into conformity with the action of the Federal Horticultural Board.

### Election to the Committee on Policy

The Committee on Policy recommends to the Association that, in general, on the expiration of the term of office of a member of the Committee, the retiring member should not be immediately renominated to the Committee.

### Association Branches

In June the Committee received a proposal that it consider a plan for the formation of a northeastern branch of our Association. The proposition was discussed by members of the Committee through correspondence and the general sentiment was at first favorable. Expressions of opinion were sought, also, from various members of the Association.

As the matter was reviewed further it appeared to the Committee that the question involved was one of far-reaching effect, which should have thorough study by the Association to the end that a policy be agreed on that may guide action not only in the present instance but in the case of future similar proposals from other sections of the country. With this in view the Committee adopted the following recommendation to the Association:

The possible establishment of regional branches of the American Association of Economic Entomologists, such as the proposed Eastern Branch, is a matter of utmost importance since it involves fundamental questions of policy.

To safeguard the essential interests of the Association, it is obvious that consideration must be given to two factors. On the one hand, no step should be taken to discourage the initiative of the members. On the other hand, care must be exercised to prevent competition with the Association. Conferences and field meetings are highly desirable, and such should be undertaken more frequently than have been attempted in the past as they stimulate interest in the subject of entomology and focus attention on economic problems of outstanding importance.

As a guiding principle, it has been suggested that instead of creating formal branches for certain geographical sections, efforts be directed to hold conferences and field meetings of members of the association residing in the same general area of the country who are interested or engaged in similar entomological problems. In other words, attendance at the gatherings should be based primarily on interest in definite projects rather than on residence in designated zones. If this policy prevails little administrative machinery will be required, and the principal items of business will be such as are incidental to the conferences.

Through the agency of such regional gatherings, opportunity will be afforded for a desirable molding of public sentiment. Entomologists can do very much more than is now attempted to direct the sources of information available to the public as to the character and the efficiency of entomological efforts in behalf of national welfare. Great good would be accomplished by holding conferences for the express purpose of observing experimental results of special significance. To such conferences there may be invited leading members of local, state and national agricultural organizations, and men of affairs, who can assist in coordinating civilian enterprises with our entomological activities. With the establishment of the Crop Protection

Institute under the direction of the National Research Council it is hoped that funds will be available for the support of important efforts of this character.

It is obvious that local circumstances may vary greatly and that different groups of members may have to consider special conditions, which will largely determine the plan of activities. Complete freedom should therefore be allowed members in calling conferences, whether regional or of special interest. Likewise, it may well be left to their discretion to determine the character of the meetings, whether conferences or gatherings with definite programs.

The Committee on Policy approves all such projects, but recommends that no active efforts be undertaken for the establishment of formal branches of our Association until and unless the members of the Association have had the opportunity to give the matter mature consideration, have determined that the creation of formal branches is desirable and have formulated principles of procedure.

## Insect Control

It is well recognized that introduced insects frequently become established in small areas without attracting notice and may give very little indication of future injurious possibilities until the infested area has increased to such an extent as to make extermination or control exceedingly difficult if not impossible.

It is evident that quarantine regulations, although designed to exclude or prevent the establishment of injurious insects in this country, as a matter of fact can be only partially effective even if there be an excellent system and a most rigid enforcement of regulations.

The above considerations, in connection with the history of introduced insects during the last fifty years or thereabouts, have led to the formulation of certain suggestions which, if put into effect, bid fair to afford increased protection to American agriculture in its various ramifications and at the sime time give more adequate recognition to this phase of economic or applied entomology.

The admirable work of the Federal Horticultural Board in administering and enforcing quarantine regulations with the numerous perplexing questions relating thereto is hereby endorsed.

It is recommended that provision be made in the immediate future for the extension of the service to ports now without adequate inspection.

Attention is called to the fact that quarantine regulations may be extremely rigid and designed to actually exclude certain destructive insects and in the judgment of your committee this type of quarantine should be limited to areas where there is at least a fair probability of absolutely preventing spread or even exterminating the pest.

On the other hand, there are conditions where quarantine regulations cannot be expected to accomplish more than to delay the spread or dissemination of an insect and when these conditions prevail, it is believed that there should be a careful balancing of probabilities and the formulation of restrictions which will result in a maximum degree of protection and a minimum interference with legitimate commercial activities.

In other words, your committee favors a distinction between quarantine measures designed for exclusion and those designed for the purpose of retarding spread.

There is great need of a more general recognition of the economy of checking the spread and controlling pests with a limited distribution. It is not economy to reduce appropriations for this type of work and a liberal policy is therefore advocated toward projects of this nature because they promote the general welfare in a most substantial manner.

The early detection and speedy control or extermination of destructive insects while they are still limited to comparatively small areas, is a matter of increasing importance.

Owing to the peculiar problems involved and the fact that control or exterminative measures necessitate an organization of specially trained men if the best results are to be secured, it is recommended that a Branch for the Control of Destructive Foreign Insects be established under the general direction of the Chief of the Bureau of Entomology, this Branch to be composed of experts specially qualified for carrying out repressive and exterminative measures.

It is obvious that the early recognition of recent introductions will promote the control of newly established pests. This is an important phase of economic entomology. An insect survey designed to ascertain the distribution and the extent of injury caused by various insects and to keep official entomologists throughout the country apprised of developments during the growing season would prove of great value in forecasting probable injury. It is recommended that an Insect Survey be organized under the direction of the Bureau of Entomology in cooperation with official entomologists of various states or state institutions.

The recent establishment of a Crop Protection Institute affords much needed opportunities for coordinated work on certain general problems relating to the more efficient control of insect pests and plant diseases. It is believed that the greatest opportunity for this organization in the immediate present lies in establishing a substantial unity of interests among its diverse membership and the demonstration of possibilities in the promotion of regional, coordinated studies by specialists along one line and of diverse specialists uniting in the solution of problems requiring special knowledge and training in several related sciences.

It is recommended that the Crop Protection Institute be endorsed and that an expansion of its field be recommended by this Association and that all members of the Association be urged to become members of the Institute.

It is recommended that the Association nominate and elect three members to the Board of Trustees of the Institute as provided in its constitution.

## Publications

It is apparent that popular articles concerning insects such as are published in newspapers and other periodicals, should be stated with greater accuracy if the public is to receive correct information. While striking and pithy statements are essential in such publications, they should not be used in place of facts.

There is at present a multiplicity of short, popular bulletins. These doubtless are valuable in so far as they are distributed to the people who are most interested in the subjects treated. A reasonable amount of funds seems to be available for publications of this character by Federal and state institutions.

The publication of original matter, as distinguished from compilations, ought to be confined to such publications as will reach those who are most in need of the information. Under present conditions, economic workers have great difficulty in keeping informed as to the latest discoveries that have been made along the lines in which they are most interested. It is therefore recommended that the reports of experimental work containing original matter should be published in bulletins of institutions or recognized scientific journals, and not in newspapers, magazines, or circulars devoted to activities unrelated to entomology.

Where early publication of important results is demanded by conditions affecting the problem, and all recognized sources of publication are taken for months in advance, it may be necessary to publish in unusual media, but in such case copies should be deposited in the Library of Congress, U. S. Bureau of Entomology and as many entomological centers as possible and information should be brought to the attention of the profession in general.

The opportunity for publication of extensive works on entomology which are invaluable to the profession, are extremely limited, but until extensive bibliographies, synoptic tables covering many of the important insects and their larvae, and handbooks such as every professional entomologist needs for reference, can be issued, the effectiveness of every worker is bound to suffer. Such publications, under present conditions, are extremely expensive, and there are not sufficient professional entomologists to make these publications financially profitable. An endowment fund to cover such publications has been suggested, but sources from which it can be raised, have not been indicated. It is hoped that within the next few years, prices of printing may reach a more normal level, and if the profession continues to grow as we have good reason to expect, it should be possible to finance and publish some of the more worthy manuscripts that are now available.

W. C. O'Kane
Wilmon Newell
A. F. Burgess
E. P. Felt
P J Parrott
E. D. Ball
Herbert Osborn
W. D. Pierce
J. G. Sanders
*Committee*

In connection with the recommendation concerning the formation of regional branches, Mr. W. E. Hinds asked if it would interfere with the informal organization known as the "Association of Cotton States Entomologists".

He was advised by the President that it would not.

Secretary Burgess traced the movement that was started in March 1920, relative to forming a Northeastern branch of the association.

A committee consisting of Mr. W. E. Britton, Mr. D. J. Caffrey, and himself, had this matter under consideration, canvassed the membership in the northeastern territory which responded very favorably to the proposal, and referred the matter to the committee on policy and executive committee of the association for approval. A field meeting was held at Philadelphia and Riverton, N. J., in July, in connection with the Japanese Beetle project, and no opposition to the plan developed. At this time the sentiment of the committee on policy was favorable, but later the committee took the view indicated in the resolution.

He stated that he was very much in favor of the formation of regional branches, believing that they would stimulate local interest and enable many of the younger members to attend meetings which under persent conditions is impossible.

President Newell stated that both the executive committee and the committee on policy had given the question a great deal of careful consideration, but as this is a rather new proposal, it is believed that

there should be further consideration by the members of the association before definite action was taken.

MR. W. C. O'KANE stated that he was at first favorable to the proposal, but was now not quite sure as to whether it was a good idea or not. He desired to have more information as to how such a plan worked out in other associations, and believed that a study of the matter should be made.

MR. E. P. FELT remarked that he was in favor of regional branches; but that if the idea was a good one, it would not suffer by action being delayed for a year or two until the matter could be given careful consideration.

MR. H. A. GOSSARD questioned the effect that regional branches would have on the interest of the members in the general association and the possibility that their establishment might prevent some members from attending the annual meetings of the association on account of smaller branch meetings being held at points where less travel would be necessary for some members to attend. He also raised the point as to whether vigorous and influential branches might not operate to the disadvantage of the general association, and stated that he believed that the matter should be considered for another year before a decision was reached.

MR. C. T. BRUES pointed out the value of branch meetings to young men who were being trained and were becoming interested in entomology and who seldom have opportunity to attend any regular meeting of the association, and suggested that the plan might be tried experimentally before it was put on a permament basis.

SECRETARY BURGESS closed the remarks on this resolution by stating that the experience of the association with its present sections and one branch indicated that they had been a means of strengthening the association.

MR. C. L. MARLATT suggested a revision of the resolution concerning the activities of the Federal Horticultural Board with particular reference to the work of the board being confined to quarantines, and after general discussion, it was voted to make the revision suggested by him.

There was a general discussion of the resolution relative to the establishment of the Crop Protection Institute, the particular point being made that members of this association elected to the board of trustees should not be immediately re-elected after their terms expired, but no change was made in this particular recommendation.

MR. R. N. CHAPMAN called attention to the interest of manufacturers of cereal products in controlling insects affecting stored foods and sug-

gested that the Crop Protection Institute ought to be broadened so that manufacturers interested in this line could participate.

On motion of Mr. E. D. Ball it was voted to amend the recommendation endorsing the Crop Protection Institute by placing the association on record as in favor of an expansion of its field.

By vote of the association, the report was adopted.

SECRETARY BURGESS stated that he had been authorized to borrow $1500 to complete the financing of Index No. II. Seven hundred and fifty dollars of this amount had been secured by $25 loans from members of the association and $300 should be raised by such loans at the meeting in order to take care of the printing bill when it came due. He requested members who were willing to make such loans to do so during the meeting.

(One hundred dollars in loans was secured before the meeting adjourned.)

He also stated that he had received a number of suggestions in regard to eliminating the discussions published in the annual report of the meeting and a proposal to discontinue the practise of having a stenographer's report, in order to save expenses. A further saving might result from discontinuing the publication of the list of officers, meetings, and members in the February number of the JOURNAL.

MR. E. P. FELT called attention to an editorial in the December number of the JOURNAL which probably had not been read by most of the members, relative to the difficulty in publishing short papers and articles that might be submitted by members during the year. Owing to the large number of papers, some of which are rather long, that are submitted at the annual meeting, it was impossible during the past year to publish short papers.

A study of the average length of papers published in the JOURNAL shows that they approximate six pages. If short articles are to be published by members who cannot attend the meeting, some regulation in regard to the length of papers is necessary.

A general discussion followed and it was voted that the maximum length of contributions in the JOURNAL this year shall not exceed six pages of printed matter; that no papers be published in the JOURNAL while other avenues of publication are available, and that papers which are likely to be published in a year, be submitted only in abstract form.

It was also suggested that a great deal of discussion at the business sessions be eliminated from the JOURNAL.

The final business was transacted Friday afternoon, December 31st.

PRESIDENT WILMON NEWELL: The first report is that of the auditing committee:

## REPORT OF THE AUDITING COMMITTEE

CHICAGO, Ill., Dce. 29th, 1920.

The Auditing Committee desires to report that it has examined the accounts of the Secretary including those relating to the first and second Indices of Economic Entomology, the JOURNAL OF ECONOMIC ENTOMOLOGY and the Association and has found them to be correct and admirably kept.

The disbursements in all cases are supported by cancelled checks or other vouchers with the exception of minor amounts involving the shrinkage due to the varying rates of foreign exchange which have caused the banks to deduct from the face value of foreign checks the discount due to this cause and which loss, in the opinion of your committee, could not in any way have been obviated by your diligent and scrupulous secretary.

The committee also has examined the account submitted by Dr. W. E. Hinds relating to the Entomological Employment Bureau and finds this to be correct and accompanied by Dr. Hind's personal check covering the amount of the balance as shown in this account and which has been turned over to your secretary.

Respectfully submitted,

W. R. WALTON
J. W. MCCOLLOCH
*Auditing Committee*

It was voted to adopt the report.

PRESIDENT WILMON NEWELL: We will now hear the report of the committee on resolutions.

## REPORT OF THE COMMITTEE ON RESOLUTIONS

1. RESOLVED, That the announcement to members calling for titles to be read at future annual meetings contain the following notice:

"Members are urged to propose one title only unless the additional subject is one of unusual and general interest. The time asked for presenting a subject of general interest must in no case exceed fifteen minutes. Subjects should be presented from written copy and not presented extemporaneously unless time can be saved by so doing. Members are urged to prepare summaries which will set forth results rather than enumerated details."

2. RESOLVED, That this Association desires to record its sympathy with the work of the Committee on Cooperation and Coordination of the National Research Council in its efforts to preserve species of birds or other animals liable to extinction, provided that such efforts do not conflict with necessary measures for insect control.

3. RESOLVED, That the American Association of Economic Entomologists express its thanks to the authorities of the University of Chicago for the opportunity of holding its meetings in the University, and also for other privileges enjoyed through their courtesy.

Respectfully submitted,

A. G. RUGGLES
ARTHUR GIBSON
M. C. TANQUARY
*Committee*

By vote of the association, the resolution was adopted.

MR. G. M. BENTLEY: I would like to present to the association a resolution that was adopted by the Section on Apiculture.

RESOLUTION ON BEE DISEASE CONTROL

Adopted by the Section on Apiculture, December 29, for action by the Association.

"The Section on Apiculture of the American Association of Economic Entomologists hereby expresses its approval of the informal agreement made by the apiary inspectors of the North Central States and Canada at a recent meeting, as follows:

Section 1. Resolved that the undersigned apiary inspectors of the North Central States and Canada believe and agree that inspection certificates for the interstate transportation of bees and used apiary supplies should be given only to apiaries which have never been infected or which have been free from American Foul Brood for at least one year.

Provided, however, that bees in combless packages supplied with food made from pure sugar only are exempted from the provisions of this Section.

Section 2. It is further agreed that whenever a case of the interstate transportation of bees or used bee supplies, with or without an inspection certificate, comes to the attention of the apiary inspector of any state, full information will be sent to the state inspector of the state of destination.

It is the further belief and recommendation of the Section on Apiculture that Federal Legislation providing for the regulation of the interstate transportation of bees and used apiary supplies should be enacted."

It was voted that the association endorse this resolution.

PRESIDENT WILMON NEWELL: The report of the committee on membership is now in order.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The committee on membership submits the following report, and recommends for election to associate membership:

Albert, Theo., Chehalis, Wash.
Alden, Charles H., Bureau of Entomology, Washington, D. C.
Balduf, Walter V., Ohio State University, Columbus, Ohio.
Bartley, Hastings N., 43 Tremont St., Boston, Mass.
Bazeley, William A. L., 519 State House, Boston, Mass.
Blanchard, Everard E., San Isidro, Argentina, So. America.
Boyden, B. L., Daytona, Florida.
Bradley, William G., Agricultural Experiment Station, Louisiana State University, Baton Rouge, La.
Brimley, Clement S., North Carolina Department of Agriculture, Raleigh, N. C.
Brinley, Floyd J., Riverton, N. J.
Brown, Luther, Agricultural College, Miss
Bynum, E. K., Ocean Springs, Miss.
Carpenter, Hall B., 58 Central St., Somerville, Mass.
Chafin, Jeff, Gainesville, Fla.
Chamberlin, Frank S., Quincy, Fla.
Craighead, Eugene M., Bureau of Plant Industry, Harrisburg, Pa.
Currier, Donald Locke, Hall of Justice, San Jose, Calif.
Darlington, P. S., Wenatchio, Wash.
DelCurto, J. M., State Department of Agriculture, Austin, Tex.
Detwiler, John D., 117 Eddy St., Ithaca, N. Y.
Dozier, Herbert L., Agricultural College, Miss.
Drake, Carl J., N. Y. State College of Forestry, Syracuse, N. Y.

Fisher, Charles K., 126 S. Minneapolis Ave., Wichita, Kansas.
Frank, Arthur, Western Washington Experiment Station, Puyallup, Wash.
Gilbertson, G. J., Brookings, S. D.
Graham, Frank W., 167 Waverly Ave., Melrose, Mass.
Haber, Vernon Raymond, 225 Linden Ave., Raleigh, N. C.
Hain, Russel M., East Lansing, Mich.
Hawkins, Kenneth, Watertown, Wis.
Hester, J. G., Box 1, Agricultural College, Miss.
Holbrook, John E. R., 17 E. Highland Ave., Melrose Highlands, Mass.
Huber, L. L., Ohio State University, Columbus, Ohio.
Huckett, Hugh C., 804 East Seneca St., Ithaca, N. Y.
Jaenicke, Alex. J., Care of U. S. Forest Service, Portland, Ore.
Jaques, Harry E., Mt. Pleasant, Iowa.
Jones, Wyatt W., 700 McCormick Bldg., Salt Lake City, Utah.
Kannan, K. K., Stanford University, Calif.
Kelley, E. B., 214 Columbia Bldg., Spokane, Wash.
Kelty, R. H., East Lansing, Mich.
King, Kenneth M., U. S. Entomological Lab., Charlottesville, Va.
Kinsey, Alfred C., Indiana University, Bloomington, Ind.
Landers, Daniel D., Cor. Nahant & Farm Streets, Wakefield, Mass.
Leach, B. R., U. S. Bureau of Entomology, Washington, D. C.
Lewis, Clarence W., 28 Albion St., Melrose Highlands, Mass.
Mabee, W. Bruce, Raleigh, N. C.
Maloney, James O., Agricultural College, Miss.
McIntosh, Allen, Agricultural College, Miss.
McDonald, R. E., State Department of Agriculture, Austin, Tex.
Miller, A. E., 67 W. 10th Ave., Columbus Ohio.
Mitchell, Theodore B., Department of Agriculture, Raleigh, N. C.
Newbegin, Irving B., Wakefield, Mass.
Paarmann, J. H., 1532 Clay St., Davenport, Iowa.
Pearson, George B., Box 95, West Lafayette, Ind.
Peirson, Henry B., Harvard Forest, Petersham, Mass.
Pollock, John H., Box 423, Colorado Springs, Colo.
Reeher, Max M., Forest Grove, Oregon.
Richardson, Theodore R., 43 Tremont St., Boston, Mass.
Robinson, Charles L., Court House, Yakima, Wash.
Root, E. R., Medina, Ohio.
Rounds, M. B., 824 N. Curtis Ave., Alhambra, Calif.
Scullen, H. A., Corvallis, Oregon.
Stage, Harry H., 1608 Oak St., Pine Bluff, Arkansas.
Tillery, J. L., Concord, Tenn.
Uichanco, Leopoldo B., Bussey Institution, Boston 30, Mass.
VanDuzee, E. P., California Academy of Science, G. G. Park, San Francisco, Cal.
Wakeland, Claude C., Paonia, Colo.
Walkden, Herbert H., 126 S. Minneapolis Ave., Wichita, Kansas.
Willson, Robert B., Agricultural College, Miss.
Wood, Elwin G., State College of Washington, Pullman, Wash.
Yuasa, Hachiro, University of Chicago Chicago, Ill.

For foreign membership:

Dr. R. J. Tillyard, Cawthron Institute of Scientific Research, Nelson, New Zealand.

Thomas Harvey Johnson, M.A., D.Sc., Professor of Biology, University of Brisbane, Queensland, Australia.

For transfer from associate to active membership:

Armitage, H. M.
Atwood, George G.
Barber, T. C.
Burrill, A. C.
Chandler, W. L.
Chase, W. W.
Cleveland, C. R.
Cole, Frank R.
Clausen, C. P.
Cotton, R. T.
Crawford, D. L.
Fenton, F. A.
Ford, A. L.
Frost, S. W.
Hagan, H. R.
Hall, M. C.
Hawley, I. M.
Herbert, F. B.
Howard, Neale F.
Jones, C. R.
Kennedy, C. H.
Larrimer, W. H.
Larson, A. O.
Lathrop, F. H.
List, G. M.
Loftin, U. C.
Mackie, D. B.
McDaniel, Eugenia
Merrill, G. B.
Mosher, Edna
Moznette, G. F.
Neuls, J. D.
Nougaret, R. L.
Oestlund, O. W.
Packard, C. M.
Sanford, H. L.
Seamans, H. L.
Smulyan, M. T.
Stearns, L. A.,
Van Dyke, E. C.
Van Zwaluwenberg, R. H.
Vickery, R. A.
Weigel, C. A.
Wolcott, G. N.
Wood, H. P.

To be reinstated to associate membership:

Champlain, Alfred B., Harrisburg, Pa.

The committee recommends that the dues of Albert Koebele and John H. Comstock be remitted and their names be retained on the roll; that the resignations of the following members be accepted:

Gates, Burton N.
Hart, Herman J.
Mason, S. L.
McGehee, T. F.
Smith, H. P.
Vansell, G. H.

That five active and seventeen associate members who are in arrears for dues for two years be notified by the Secretary that if the amount due the association is not paid promptly, their names will be dropped from the roll.

Respectfully submitted,

T. J. Headlee
E. R. Sasscer
A. G. Ruggles
*Committee*

By vote of the association, the report was accepted and the recommendations adopted.

President Wilmon Newell: The report will now be presented by the committee on the U. S. National Museum.

## REPORT OF COMMITTEE ON U. S. NATIONAL MUSEUM

Your committee begs leave to report, as follows:

First: Activities during the year 1920.

In order that all might understand the importance of the Division of Insects of the U. S. National Museum and realize its needs to handle the vast volume of material submitted to it by entomologists for study and information, our report, submitted at the last annual meeting at St. Louis was printed in *Science* as well as in the entomological journals, and reprints furnished to entomologists throughout the country for their use in advising on the subject. As a result the report was approved and assistance extended by the National Research Council, the Florida Entomological Society and the Indiana Academy of Science.

An itemized budget was not included in our report a year ago but the past year this matter has been carefully studied and a budget totaling $83,660 was decided upon as the amount needed at once. This amount is considered adequate to provide the needed curators, assistants and preparators, and will also furnish a suitable allowance for the purchase of needed supplies and equipment and permit a small amount for travel and exploration and in addition make it possible to inaugurate proper facilities for publication. This budget was presented to Dr. C. D. Walcott, Secretary of the Smithsonian Institution, October 1 with the urgent request that he include the item in his budget for the National Museum. This could not be done as the budget had been sent to Congress previous to June but Doctor Walcott generously agreed to approve the item provided its inclusion by the house committee could be secured. Consequently the matter was taken up with Congressman Good, Chairman of the House Appropriations Committee, Doctor Walcott at the same time approving the item in a letter to Chairman Good. To this request we were advised that owing to the deficiency in the Treasury and the many needs confronting Congress that additional appropriations could not be considered at this time. After careful consideration your committee believes it advisable to refrain from pushing the matter at the present session of Congress but to request insertion of the item in the Museum budget at the next session of Congress.

Second: Support needed. Your committee urges every member to be in readiness to secure the indorsement for National Museum support if needed. This refers to personal contact with your representatives in Congress or otherwise securing their support. We would urge especially that the scientific societies of the different states be advised of the needs and that their indorsement be secured and likewise that the approval and support be secured from such agricultural bodies as the state horticultural societies, agricultural societies, etc.

We would urge that each one of you take every opportunity to educate the people relative to the importance and needs of the National Museum as a whole for we must build up every branch of the Museum if in future years we are to maintain a normal growth and expansion of the Division of Insects.

Third: Deposition of Types in the U. S. National Museum. Your committee feels that the National Museum should be the mecca for taxonomic entomological activity in the United States and would urge that entomologists make it a point to deposit types in the Museum. We would urge state institutions to likewise place the types, now in their collections, in the custody of the National Museum. This is already being done by certain institutions. Thus the type collections of the Connecticut Agricultural College, Colorado Agricultural College, Kansas Agricultural College, The Norton Collection at Yale, and others, will all probably soon be in the National Museum. We cannot urge too strongly that other institutions and individuals

follow suit. In return the Division of Insects of the Museum promises to give the donors species new to their collections and help to build up their collection along the lines which will be most valuable to them. They further agree that any of the types thus deposited are accepted on the condition that they can be borrowed by the institution at any time and for any reason, but they are not to go to any institution or individual, not connected with the institution presenting the material.

Respectfully submitted,

JOHN J. DAVIS
W. J. HOLLAND
V. L. KELLOGG
E. P. FELT
HERBERT OSBORN
*Committee*

By vote of the association, the report was adopted.

PRESIDENT WILMON NEWELL: Nominations by the advisory committee for the officers of the JOURNAL OF ECONOMIC ENTOMOLOGY are now in order.

DR. L. O. HOWARD: On behalf of the advisory committee, I will renominate the officers that served during the past years.

By vote of the association, these officers were re-elected.

PRESIDENT WILMON NEWELL: The next in order is the report of the committee on nominations.

## REPORT OF THE NOMINATING COMMITTEE

For President, George A. Dean.
First Vice-President, Arthur Gibson.
Second Vice-President, E. O. Essig.
Third Vice-President, A. G. Ruggles.
Fourth Vice-President, H. F. Wilson.
Secretary, A. F. Burgess.
Committee on Policy, Wilmon Newell.
Committee on Nomenclature, Edith M. Patch.
Committee on Membership, J. S. Houser.
Committee on U. S. National Museum, Herbert Osborn.
Representative National Research Council, P. J. Parrott.
Councillors for American Association for the Advancement of Science, A. L. Quaintance, T. J. Headlee.
Trustees Crop Protection Institute, W. C. O'Kane, 3 years; P. J. Parrott, 2 years; J. G. Sanders, 1 year.
Advisory Committee, C. H. Popenoe, H. A. Gossard.

Respectfully submitted,

JOHN J. DAVIS
C. L. METCALF
J. E. GRAF
*Committee*

By vote of the association, the committee was instructed to cast the ballot of the association for the nominees mentioned in the report, and they were declared elected.

PRESIDENT WILMON NEWELL: Will Past Presidents Howard and Felt conduct Mr. Dean to the Chair?

MR. GEORGE A. DEAN: Mr. Chairman and Gentlemen: If my heart, which is trying to function in my throat, would just drop down to the location that it should occupy normally, I will try to express in my weak way my appreciation of this great honor that you have bestowed upon me. I have never had such a feeling come over me as I have right now. It is not one of joy; nor is it one of sorrow or regret; perhaps it is a feeling that comes over one when he suddenly realizes how unworthy he is of the great confidence and faith that his friends have placed in him. I trust I will realize to no small degree the responsibility of this position. I hope that I may have the support and the help of all of you, and that I may be able to grasp some of the essential problems of our great Association. If it were not for the splendid men that are on the Executive Committee and the Committee on Policy, and all these other important Committees, and the splendid men that are in the Association, I never would think for one moment of assuming this responsibility. I trust I am in position and I believe I am,—to give considerable of my time to the Association. This I do know: the interest of this Association will be paramount in my mind, and I promise you, without any reservations, that I will give you the best there is in me. (Applause)

PRESIDENT WILMON NEWELL: Is there any miscellaneous business?

MR. ARTHUR GIBSON extended an invitation to the association to meet in joint session with the Entomological Society of Ontario at the annual meeting next year at Toronto.

The President expressed appreciation for the invitation and on motion the matter was referred to the executive committee with power to arrange the details.

The Secretary called attention to the members of the success of the joint session with the Phytopathologists and asked whether arrangements were desired for a joint meeting next year.

It was voted that this matter be left to the executive committee with power to act.

It was voted that the time and place of the next meeting be left to the executive committee.

On motion of Dr. L. O. Howard, a resolution of thanks was extended to President Newell for his successful handling of the meeting.

# PART II. ADDRESSES, PAPERS, AND DISCUSSIONS

*Morning Session, Wednesday, December 29, 1920*

After the routine business of the opening session had been transacted, President Newell introduced Dr. C. E. McClung, chairman of the Division of Biology and Agriculture of the National Research Council, who spoke as follows:

It is a great pleasure to meet with you and to discuss briefly some of the problems which confront the Council. I should like, in the first place, to acknowledge the indebtedness of our Division and of our Executive Committee to the efficient services of your respresentative, my old friend, Dr. Parrott. As he has told you in his report, he has attended all of our meetings and has contributed very largely to the discussions that have been held.

This morning I should like very briefly to indicate to you the nature of the Council and some of its problems. It is especially important that you understand what this organization is. There is much misapprehension, some of it natural, some of it, I am sorry to say, cultivated. It is particularly important that you know that this organization is your own. It is not something which exists outside of the national scientific societies; it is a creature of those societies, and it represents you as an organization. The unit on which the Council is established is a national scientific society. It is not an organization to impose upon any individual or group of individuals any policy or method or point of view. It is in effect, as Dr. Parrott has told you, a congress of the scientists of the country, an organization through which they may express their views, through which they may operate in the execution of their projects, and in no sense is it designed to impose any plan or any point of view upon the scientists of the country.

I want to be especially emphatic about that because you will be told by those who have not looked into the matter that there is some effort on the part of certain persons, undesignated, to attempt the control of the scientific life of the country. In the nature of the organization that is quite impossible. It was designed especially to prevent any such thing as the development of a group that might wish to do such a thing as that, because the members are elected for short periods of time and the officers for a year.

I happen to be in Washington this year, and Dr. Jones of Wisconsin will be there next year, and somebody else will follow him as Chairman of our Division. The organization is plastic and moves rapidly, and there is nothing in the nature of it which would make possible a coercive body. On the other hand, it does offer the scientists of the country a

form of organization which can be made effective in a great many ways, and that is to be determined by those who wish to be served and not by any one else.

You can readily see that with a group of men in Washington representing the different sciences—men permanently on the job—you may hope more effectively and readily to accomplish your purposes than if you have to work through the looser organizations which have heretofore existed. You have in effect, in appointing your committee on cooperation in the Council, a permanent court representing you to which we can appeal for advice on the subject of entomology. The Division of Biology and Agriculture is unique in this respect: that we have asked all of the societies represented in this Division to name these Committees.

Dr. Parrott has told you that the Council is in a state of development and its entire organization is such that it may be changed at any time to meet the needs of the scientists of the country. Its subsidiary organizations are of the same nature, and the Crop Protection Institute is of like character. The Council has no other interest in this particular Institute than to serve as a means of bringing together groups which we are told had heretofore not been able to get together. That represents in general one of the large functions of the Council.

When the matter of bringing this proposed Institute to the attention of various scientific societies was discussed, I suggested that the Phytopathologists be considered, and it was found that it would be desirable for them to work in cooperation with the entomologists. I have been told that the phytopathologists have already, as a society, endorsed this project, so that if your Association decides to do so the matter will be well started.

Already we have had statements from the Forestry Committee that they are interested in this matter, and it may be that it would be desirable to include representation from the foresters, and to extend it possibly to others.

This represents perhaps, the only immediate way in which the Council has been of service to the entomologists so far, but I should like very briefly to point out to you that there are other connections which you may set up. One of those has already been referred to by one of your speakers in reference to the protection of natural areas. The Ecological Society has a Committee which has done a large amount of work in the effort to preserve for scientific study areas which are in a natural condition now but which are very soon to disappear entirely.

You will at once realize that conflict of interest may be set up in anything of this sort. Some of those were briefly referred to. Some organizations might want to preserve areas that harbored very destruc-

tive parasites, insects, fungi or other things. It would be a question to decide whether it is more desirable to keep that area or to get rid of that particular group of destructive organisms. That would be difficult unless you had, as you have in the Council, a congress of scientists already established to consider these matters for you. Always it should be the case that if these are of great importance they come back to the different societies for final action as they have in the case of this Crop Protection Institute. That should be an invariable practise of the Council, because as it represents the societies it ought to take every precaution to see that that representation of sentiment is as full and as exact as can be obtained.

I should like very briefly to speak of several connections which you might as entomologist set up with projects in process of organization and which would be of much possible interest to you. One has also been briefly referred to here—that of the relation between entomology and forestry. We have a very active and energetic forestry committee which has now in progress an extensive investigation in the Southern States upon the reforestation of that region and upon methods of sylviculture. I should just like to speak of this for a moment to indicate to you how connections are established and projects put under way. This committee represents the American Forestry Association, and presented to that Society certain projects which it thought of greatest significance. Two of them were the ones which I have mentioned. In order to be certain that the Council should not undertake something for which provision was already made, after these projects had been properly approved, I went to the Chief Forester and explained the situation to him, asked him if this work duplicated the work of the Forest Service and if not did he consider it a desirable thing to undertake. It was at once approved by the Chief Forester, and then Dr. Howe, Chairman of the Research Extension Division of the Council, who assisted you in the organization of this Crop Protection Institute, addressed the Southern Pine Growers' Association and received from them a grant of $10,000 for the prosecution of this project.

The Chairman of the Committee told me the other day that already from the Forest Service and from the state services contributions equivalent in amount to what the Southern Pine Growers had contributed had been received.

This Committee on Forestry, it seems to me, could very properly be put in relation to your Committee of Entomology to determine what best could be done in the matter of forest entomology, if there should be things for which you do not already have provision, as I judge to be the case from what has already been suggested.

We have a Committee representing the Horticultural Society, which I should think could in many cases be put directly into relation with the work of the entomologists. This Committee recently had a meeting in Washington and has undertaken to determine the presence and extent of various kinds of fruit plants in the country in order that they may be preserved and brought together for better service.

The Committee on Phytopathology has already been brought into relation with the work of this association and the Crop Protection Institute. There may be other connections which you could set up. If, so, the agencies are already provided.

We have under way the organization of an institute for tropical American research, and recently in Washington we had reports from the men in the Philippines who have been responsible for the excellent development of scientific work there. Some of our own fellow-scientists have spent as many as eighteen years in the Philippines developing a group of institutions which stand out most prominently as an achievement of American science.

It is pointed out to us that this country of all large countries has the least knowledge and least connection with the tropics and that in the future the food supplies and the raw products in particular must in a largely increasing degree come from the tropics.

It was mentioned, for instance, that in this country we use, as I recall it, over eighty per cent. of the rubber of the world, whereas Great Britain controls ninety per cent. of the source. As you have read in the newspapers, we cannot lay cables because Great Britain has control—entire control—of gutta-percha, and it leads to an international complication simply because this raw product is unavailable to us. Many such instances were pointed out.

We called a meeting of representatives of the large universities, museums, and societies in Washington, to consider the organization of an institute for tropical American research. This is being put actively under way. There is a Committee at work on the organization of this institute, and we have assurance from the Pan-American Union and the State Department that the efforts will be encouraged in every way. It is certainly true, I should think, that the entomologists would be greatly interested in the organization of such an institute as the tropical American research institute.

We have a Committee on Food and Nutrition, whose work in the preservation of foods particularly comes into close connection with the entomologists.

There are many of these things; I have spoken merely of a few in the Division of Biology and Agriculture. I have done this merely to direct

your attention to the situation and to ask your earnest support of the work of your representatives in the Council, which I can assure has been of the highest order.

I thank you very much for the opportunity to present the work of the Division. (Applause)

PRESIDENT WILMON NEWELL: Our thanks are due Dr. McClung for this very clear explanation of the work of the National Research Council and our relationship to it.

Another paper along similar lines is that by Mr. W. C. O'Kane, on "Industrial Support for Scientific Work."

## INDUSTRIAL SUPPORT FOR SCIENTIFIC WORK

By W. C. O'KANE, *Durham, N. H.*

(Withdrawn for publication elsewhere)

Adjournment.

*Afternoon session, Wednesday, December 29, 1920, 2.15 p. m.*

Vice-President Gossard in the Chair.

VICE-PRESIDENT GOSSARD: We will now listen to the Presidential Address, "On the Organization of Work in Economic Entomology," by President Newell.

## ON THE ORGANIZATION OF WORK IN ECONOMIC ENTOMOLOGY

By WILMON NEWELL, *Gainesville, Florida*

Considering the relatively short period during which our profession has been adapted to important practical and economic ends its development has been marvelous. It may be that because of this growth work in economic entomology is not as thoroughly organized as in some of the older professions or vocations. The time has undoubtedly arrived when we must give thoughtful attention to so coordinating and organizing our activities, both as individuals and as groups of individuals, as to place our profession on that high plane which its usefulness to society justifies.

Much is implied in the term "organization". In reality it covers everything in the entomological field from teaching a student the principal parts of the grasshopper's anatomy to the management of relatively large and momentous undertakings, such as eradicating an injurious insect or excluding foreign pests from our country.

The present status of work in economic entomology, taking the United States as a whole, must appeal to the student of organization as being somewhat chaotic. Various state agencies, such as experiment stations, boards of entomology and horticulture, state departments of agriculture and plant boards are working on entomological problems; in many instances without adequate funds and in most instances in ignorance as to whether the same problem is being investigated by other state workers, by the Bureau of Entomology or by both. At the same time we find the Bureau of Entomology establishing field laboratories throughout the country for the study of various insect problems, some of the latter almost national in scope but many of them also local in character. The state entomological workers in the states where these laboratories are located are not infrequently in ignorance of the particular objects sought by the federal investigators and may even be ignorant of the major lines of effort or the problems being pursued. It may easily happen that both state and federal entomologists may work upon the same problem, entirely without co-operation. Is this condition conducive to securing the maximum of efficiency and useful results with a minimum expenditure of time and resources?

The speaker is convinced that there is room for vast improvement along these lines and, what is more important, improvement must be made in this direction if the entomologists are to maintain a prestige which will compare favorably with that earned by workers in other lines of agriculture.

The entire question of organization and all that it implies is a very broad one and we cannot hope to do more, in this brief essay, than to direct your attention to some aspects of organization in the entomological field. This we propose to do with reference to (1) the individual worker, (2) workers in other lines of agriculture, (3) major projects and (4) the relationship between federal and state workers.

## 1. The Individual

It is not our purpose to discuss the work of the teacher of entomology for the same pedagogical principles apply here as in the teaching of other biological subjects. Neither do we include in our field of discussion the entomologist *per se*, meaning by this the person who pursues the study for the primary purpose of securing entomological information without particular regard to its economic application. The primary requisite for such an entomologist is time in which to pursue his labors.

It is with the organization of entomological work of an economic nature that we are now concerned, for our profession takes on certain aspects of business in that the information we seek or impart is to be

applied to practical ends; if not in the immediate future, then ultimately. Knowledge such as we use may be compared to the stock in trade of a commercial house in that it should be readily available when needed or called for. If we find there is a coming or growing demand for certain information which we do not have in stock good business practice demands that we proceed to "stock up": in other words, acquire the needed information, usually by research methods. Our research projects, unlike those of the entomologist *per se*, must in most cases be completed within a specified time and the "goods delivered" when they are needed. Research along the lines of economic entomology must therefore recognize the time factor and he who pursues such investigations leisurely and without having in view definite accomplishments within a specified time is neglecting one of the cardinal principles of success.

The organization of the individual entomologist's work is mainly a question of personal efficiency and many factors play a part in it. The proper selection of problems upon which to work often determines whether a year or more of time is advantageously used. The need of the day is clearly for entomological results that admit of practical application. This is the object of economic entomology and the worker must needs guard against devoting his time and efforts to problems which are not of prime economic importance.

No economic entomologist can ever say that his day's work is "done" for if he considers it as finished it is but proof that he has failed to see the opportunities all around him—for experimentation, for service to the public and for extension of entomological knowledge. The amount of work confronting every entomologist is, for all practical purposes, infinite and a fine distinction is therefore necessary between those tasks which are most fruitful or important from the standpoint of practical results and those which can be deferred, or even eliminated, without regrettable consequences. "Do not put off until tomorrow what can be done today" is a rule which can rarely be applied by the economic entomologist. Instead, his rule must be: "Do those things today which are most important today." No efficient entomologist commences his day's work without having in mind a definite plan: a conception of what is to be accomplished. True, many unexpected things may develop to prevent the execution of that plan and the latter must be constantly rearranged and readjusted as the day passes, but a definite aim is the first requisite for definite accomplishments.

Freedom from worry over personal financial affairs is one of the most important essentials for good results from the individual worker. Such a condition presumes adequate salaries. Salaries of entomologists are, at the present time, inadequate. It may be argued that they are as good

on the average, as those enjoyed by university professors and others whose duties require similar training and experience. It must be remembered, however, that the services of the economic entomologist possess a definite commercial value, a value in most instances many hundredfold in excess of his compensation. The salaries of our best entomologists should compare favorably with the incomes of our best physicians and lawyers and the salaries of younger entomologists or those in subordinate capacities should be graduated accordingly. The action of this association, at its last meeting, in establishing a standard of values for entomological services was a step in the right direction. It must be remembered, however, that there are many entomologists who are still "pegging away" at unimportant tasks and others who are "marking time" on important projects. Naturally the public does not appreciate their efforts and lack of definite accomplishments by them only tends to minimize the value of services rendered by the profession as a whole. It is also true that as economic entomologists we have not yet accomplished any really stupendous tasks: tasks of such economic importance as to be the subject of comment and commendation by the public generally. When we do, we can talk with better grace about higher salaries.

While on this phase of our subject we wish to remind the student of personal efficiency that he will find a wealth of wholesome advice and inspiration in that masterful address, "The Day's Work," delivered by President O'Kane before this Association one year ago.

### 2. Workers in Other Lines of Agriculture

In our relationships with other agricultural workers we have vast opportunities for improvement. We have been too prone to regard an insect problem as one for the exclusive attention of the entomologist. Primarily and in so far as the form, habits and biology of the insect is concerned, it is but in the practical application of entomological information much other knowledge, presumably supplied by workers in other lines, is always necessary. The tendency of all scientific workers has undoubtedly been too much in the direction of specialization. What we should do is not to consider a problem as an "entomological" or a "chemical" or a "pathological" one but to consider it collectively, from the standpoint of all the scientific questions involved and bring to bear upon it the combined knowledge and experience of the entomologist and the plant pathologist, agronomist, soil physicist or whatever other specialist is able to furnish information or experience contributing to its solution.

We have also failed, in the writer's opinion, to recognize and apply sufficiently broad principles of insect prevention or "entomological hygiene." In most problems of this character workers in other lines must be called into consultation or even active participation. The prevention of insect outbreaks invariably involves questions of crop rotation in which the agronomist is concerned or practices of pruning or orchard management with which the horticulturist is concerned and not infrequently problems of fertilization, soil management and plant pathology are involved. A broader viewpoint and more liberal practice in these matters are much to be desired.

## 3. Major Projects

Developments within recent years have made it necessary for entomologists to engage in undertakings involving the services of many individuals. Problems in plant quarantine service, the control of a serious pest over a large area, the eradication of introduced insects, which have become established: all call for organizations of workers far in excess of what was even dreamed of by the entomologists of twenty years ago. These big undertakings have come upon us quickly, in some cases almost overnight, and we have not yet reached a standardized plan or basis of organization for them. The handling of such problems is not unlike that of handling a big factory, with its various departments, or a big commercial enterprise. Organization in entomological work is only in its beginning and it is a subject to which we must give careful thought.

A major project in any branch of applied entomology must have the moral support of the public, or at least that portion of the public directly affected by it. No organization, for example, could hope to eradicate an insect enemy of a staple crop unless the effort were supported by the producers of the crops subject to attack. Public support arises from a knowledge on the part of the public of the merits of the undertaking. Sometimes these are recognized through a threatened calamity, the nature of which is known to all. In other instances this knowledge is the direct result of education but there must always exist a conviction that the undertaking is a necessity.

Ample resources in the way of funds for carrying through the proposed program, together with adequate laws and police regulations are prime necessities.

Public confidence in entomological work has frequently been seriously impaired bv failure of the workers themselves to eliminate the possibility and probability of insect pests being disseminated by their own activities. It is always difficult for a property owner to understand why it is unsafe for him to do certain things when it is "all right" for an entomol-

ogist or inspector to do the same things. We regret to say that there have been instances of entomologists transporting living specimens of an injurious form into non-infested territory for the purpose of conducting experiments with them! Failure to exercise every precaution to prevent the spread of injurious insects by the entomological workers themselves, quickly destroys public confidence, the first requisite for public support.

There must be division and subdivision of the working force into groups or departments, each group specializing upon some particular phase of the problem or undertaking; yet the work of all groups must be correlated without perceptibly overlapping.

Conferences between the chief executive and the division or department heads should be held frequently, not only for the purpose of discussing routine matters and thus keeping all familiar with the general work of the organization but also to consider special problems of practice or policy. A wise executive will seek expression of opinion from his department heads and give consideration to their views, even though final decision and the responsibility therefor rests with him. In a sense, the relations of chief and minor executives should be those of general and staff. In like manner conferences should be frequently held between department heads and their subordinates and so on down, until every member of the organization, no matter how humble his position, has been reached.

With all of these conditions fulfilled the success of the organization itself will depend upon many things which, at first thought, may appear to be relatively unimportant. The first of these is morale, something which is hard to define and still harder to create. Morale does not exist unless the workers are men of high moral character, honest, conscientious and good citizens. This requirement is of even more importance than technical training for the particular work in hand. Perhaps one of the greatest factors in morale is leadership and all that the word implies, for the workers must have implicit confidence in their leader, his ability, integrity and sense of justice. He must see to it that there is no partiality as between employees, that promotions are made on merit and ability regardless of the employee's technical training or collegiate degrees. Of equal importance is the prompt elimination from the force of all those who are unfit either through ignorance, laziness or personality. The selection and assignment of executives in minor positions is also of importance as these officials are in closest touch with the actual workers and must reflect in large degree the policies and attitude of those higher in command. Personal contact between field force and headquarters is a vital factor, for leadership is

largely a matter of confidence, based on personal contact and experience. Employees from the lowest to the highest should be given opportunity to offer their suggestions and to confer with fellow workers and leaders. It must be remembered that the humblest workman in a factory may make an important invention or a marked improvement in manufacturing methods: in the same way the humblest field worker may find the solution of difficult problems or a better method which may go far towards insuring the success of the undertaking.

Admitting to the organization persons who receive their appointments for reasons of political expediency, whether such persons be competent or not, will quickly destroy the morale of any force of workers. Justice and a "square deal" are perhaps more instrumental in maintaining morale than any other factors. The employees must have enthusiasm; not the bombastic kind but that kind which manifests itself in duty well performed, in a firm belief in the merits of the project and confidence in its ultimate success. A certain measure of responsibility must also rest upon each individual worker. He must be held responsible for the accomplishment of certain definite things, either great or small, but must, at the same time, feel assured that he will receive credit for what he accomplishes as a factor contributing to his future promotion.

An executive can well afford to be over-liberal with his subordinates in the matter of "credit," for any accomplishment which reflects credit upon a member of his organization reflects credit upon himself as well.

Authority must be centralized. When different agencies, such as the state and federal governments, work in cooperation, the activities of both should be directed by one and the same executive. By this means are duplications of effort, waste of funds and petty jealousies eliminated.

Scientific research must go hand in hand with the actual application of repressive or control measures and should keep pace with the latter. Until recent years entomologists have held quite tenaciously to the contention that thorough life-history studies should precede practically all attempts at control or repressive measures and even today we can see evidence of this belief in the attitude of some entomologists towards the larger entomological problems confronting us. While we do not wish to be understood as discounting in the least the value of such knowledge, nevertheless it does not necessarily follow that a large-scale attempt to control or eradicate an insect pest must wait upon the acquisition of all desired information concerning its biology, parasites, etc. It must be admitted that all possible or available information in regard to a pest is desirable and a certain amount is necessary for intelligently handling an eradication or control project but to hold a project in abey-

ance while scientific investigators are pursuing research work would in some cases mean that the attempt would be foredoomed to failure for if the insect is permitted to have its own way while the investigators pursue their labors, it occupies new territory or increases to such an extent as to make the proposed undertaking impractical of accomplishment because of prohibitive expense. It is much as if an army were to persistently refuse to attack the enemy until all details of the latter's position, strength, weapons, fortifications and reserves are known. Like the army in war, we must rush to the attack without waiting to be sure we will win. To know that we have a "fighting chance" is sufficient warrant for putting forth our strongest efforts and, as in other wars, the advantage is with the side which takes and holds the offensive.

The directors of any project involving the expenditure of relatively large amounts out of the public treasury and affecting in an economic way large numbers of citizens must take the public into their confidence. Judicious but truthful publicity is therefore a necessity. The admission of temporary failures and the acknowledgement of mistakes are as important as supplying to the public information on the encouraging features. This policy of taking the public into our confidence inspires belief in our honesty of purpose and prevents the development of that suspicion with which the layman or the public is so apt to regard work involving scientific men or the expenditure of public funds. Publicity must emanate from headquarters rather than from operatives in the field. The reasons for this are obvious. At the same time, information must be of such a nature as to avoid the appearance of being "propaganda" in the sense that the word is now taken, namely, an attempt to create sentiment for or against an undertaking. It is needless to say that no feature of the work should be so manipulated as to forward personal interests. Even the appearance of such a condition should be carefully avoided. For a nursery inspector, for example, to own stock in a nursery is to at once raise a suspicion in the minds of the public as to his loyalty and to raise in the minds of the nurserymen a question as to the sincerity of purpose behind the entire nursery inspection service.

In an extensive undertaking the executive or directing official occupies the most responsible place. On his character and conduct to a great extent depends the morale of the working force. He must be patient with employees and citizens alike, he must be familiar with all branches of his organization, firm in dismissing those employees who are unfit or who commit any moral error, yet exceedingly charitable in the case of mistakes which are made through ignorance or inability but with the best of motives. In the enforcement of laws and regulations he must

be fearless, yet not foolhardy and must remember that the success of an entire undertaking is sometimes jeopardized by a too zealous activity in bringing about punishment for violations which in themselves are relatively devoid of serious consequences. Perhaps the greatest difficulty which the conscientious executive has to face is that of relinquishing many duties to his subordinates with the feeling, perhaps, that he can perform them just a little bit better than can some one else. The general manager of a railroad system cannot also be dispatcher and train conductor and the entomological executive must delegate to subordinates many duties which he probably can attend to better than they. The executive himself must some day give way to another and an efficient organization requires that every man in it should be prepared and qualified to step into the place of the man higher up, including the place of the executive himself. Details and routine matters must go to subordinates. If the latter cannot perform these tasks they should be taught; if incapable of being taught they should be replaced by more competent ones. One buried in a mass of details loses perspective. The head of a large working organization not only must not lose perspective; he must have the leisure in which to create a forward perspective and see far beyond the tasks and plans of today.

## 4. State and Federal Workers in Entomology

This phase of our subject is one which the speaker approaches with some hesitancy. It is a subject frequently discussed by the state workers on the one hand and by the federal workers on the other—but rarely by both together. Because a subject may be considered by som as more or less "delicate" is not necessarily a reason for ignoring i It may also be a vital subject. Truth is the basis of all perfect understanding and when one knows the facts and motives actuating another in his attitude, a common ground of understanding is shortly arrived at. If the present discussion has any purpose at all, it is that of making a plea for more perfect cooperation and coordination of all the agencies engaged in economic entomological work. At the risk, therefore, of invoking some criticism, the speaker ventures to touch upon what appears to him to be vital phases of the relationship between federal and state workers in economic entomology.

That this relationship is at present by no means ideal will doubtless be conceded by all. By this we do not mean to infer that there is a feeling of antagonism or jealousy between these two groups of workers for such is self-evidently not the case. Rather, these two groups are the victims of circumstances for which they are only in part responsible, if indeed they are really responsible at all. We have already referred,

in our introduction, to the unnecessary duplication of work by these agencies and to the manner in which problems, essentially local in character, are sometimes handled by the federal Bureau of Entomology to the embarrassment or impediment of the state workers. The rapid expansion of the Department of Agriculture has many times resulted in the Department taking up problems, for the common good, in states where the legislatures either could not or would not provide facilities for doing so. There has also been an insistent demand that the federal government assume the role of patron to the end that state legislatures may "conserve" the state funds.

The Bureau of Entomology should function mainly in a regulatory and advisory capacity, should be the "central supply station" for entomological knowledge and council, a clearing house for experimental results and an institution to cope with those problems which involve activities clearly extending beyond the borders of any single state. For the Bureau to establish field laboratories for the study of problems largely or entirely local in character is to draw attention of the public away from the field and activities of the state institutions, to the detriment of the latter. With the inception of a federal laboratory in any locality the growers come to expect greater things from the federal undertaking than can possibly be realized. The publicity attending the establishment and maintenance of such field laboratories or stations creates in the minds of legislators an inclination to let the government solve local problems and they accordingly make this the excuse for not properly supporting their own state institutions. The speaker has in mind the case of a field laboratory established by the Bureau for the study of tobacco insects. The tobacco growers of the State in which this field station is located have come to look upon this station as their only source of information on insects affecting tobacco. They do not apply to their state entomologist for help or information or even to their State Experiment Station or Extension Service for assistance along any line. Consequently they have no interest in their state institutions, their representatives in the legislature have none and oppose appropriations for agricultural work of all kinds and the entire state, including the tobacco growers themselves, suffers the consequences.

It is no more logical for the Bureau to establish and conduct field stations, exclusively under its own management and direction, for the study of a certain insect or the insect enemies of a certain crop, than it would be for the Department of Agriculture to establishment agricultural colleges in competition with those now in operation by the several states, appoint their faculties and direct their operations exclusively from Washington. We do not wish to be understood as contending

that the Department of Agriculture should not conduct research or investigational work. It is necessary for the Department to engage in certain kinds of research work in order that its policies and advice may be based upon accurate knowledge and correct principles but when the investigational work touches directly the agricultural interests or practices of any state, the Department's effort should be through the state institutions and state agencies. Such a course would greatly aid these institutions, would bring added prestige to entomological investigation and would in no wise react to the detriment of the federal bureau. On this aspect of the question permit us to quote from no less an authority than Professor L. H. Bailey:

> " . . . every movement that tends to weaken local responsibility and initiative is a distinct menace to the people Whenever the people are taught to look beyond their own institutions to federal institutions alone, they lose opportunity and power to help themselves. The people and the states are at fault in calling to Congress when they should call first to their legislatures."[1]

One may properly ask: "What is more natural than for the people to look to the federal government rather than to their own institutions when the federal government itself encourages this attitude?"

It will perhaps be said, in reply to these contentions, that many entomological problems must be studied in different states and sections in order that reliable conclusions may be drawn. This is true but the regional data needed can be secured as readily and as cheaply through the state institutions—and frequently will be more reliable—than if secured by special investigators, often unfamiliar with local conditions, sent out from Washington. The objection may also be offered that the federal Bureau must sometimes investigate or otherwise deal with insect problems or outbreaks when the state in which these occur does not provide the funds for doing it, particularly when the insect is one which may presently invade other states. Such instances sometimes involve insect pests of the most dangerous nature, as witness the recent appearance of the Mexican bean beetle[2] in Alabama, and in such circumstances federal help should come quickly and unfailingly.

It would appear that the problem of coordination here presented could be solved by either of three plans: (1) for the federal government to place certain of its funds at the disposal of the state agencies subject, of course, to the conduct of the project and the personnel of those engaged in it meeting the approval of the federal authorities, (2) by the federal government placing its own agents at the service of the state authorities or (3) by federal agents working in close cooperation and

[1]Presidential Address before the Association of Agricultural Colleges and Experiment Stations, May 28, 1907.

[2]*Epilachna corrupta* Muls.

under a uniform plan with state agents, although continuing to be directly responsible to the head of their own Bureau.

In very recent years there has come a new and striking development in entomological practice, that of earnestly attempting the eradication of injurious forms. This definite type of activity is not confined to the entomological field, for numerous campaigns to eradicate plant diseases are under way and veterinarians have demonstrated their ability to successfully prosecute the work of eradicating an animal parasite, the cattle tick. These various eradication projects have been taken up independently by different agencies, both federal and state, without any apparent attempt at coordination and, we fear, with a none too clear appreciation of the principles involved. Whatever these principles may be, they are the same for all eradication projects; the latter differ only in details according to the form or habits of the organism being dealt with. Does it not seem that the time has arrived when the principles underlying successful eradication work should be clearly enunciated and that certain workers should qualify as "eradication experts," regardless of whether the eradication problems involve insect pests, plant diseases, animal parasites or infectious diseases of domestic animals? Perhaps it would be regarded as visionary to suggest that "bureaus of eradication" be established to deal with these projects, but if eradication measures are to attain that degree of success now hoped for such a development will be inevitable. Indeed, Dr. E. P. Felt has already suggested, in his address before the Entomological Society of Ontario on November 17th, the creation of an organization specially qualified to deal with emergencies created by the establishment of new insect pests and that provision should be made in annual appropriations for funds with which to deal with such unforeseen contingencies.

## Conclusion

Although the progress of economic entomology has been marvelous and much has been accomplished, the rapid growth of the science has brought about a more or less chaotic condition in that many agencies are operating without proper coordination. One is reminded of a vast army, made up of many units enlisted in the same campaign, but operating with concerted action between certain divisions only and at times even in competition with each other. The next step forward in our profession should be the coordinating and harmonizing of all activities, at least in related fields. Only by such a development, on broad and constructive lines, can economic entomology be made to render the maximum of service and usefulness to the ultimate object of its efforts, namely, the public.

VICE-PRESIDENT GOSSARD: After having listened to this very excellent address from one of the most capable of our members and the head of a large organization, I am sure you will wish to discuss the matter.

MR. W. C. O'KANE: Every one of us here is sitting quietly waiting for the other man to speak first. I would like to do this, too, but I cannot let this opportunity go by without expressing my personal appreciation of President Newell's address. Not every man has the courage of his convictions, and not every man has convictions that are worth putting courage into. He has both. When you listen to an address of this kind you must have the same sort of feelings that I have, that the whole future development of economic entomology is so enormous that you wonder how we are going to undertake it. I never have heard an address in this association that had as much suggestive and constructive work in it. I only wish that it were possible for Mr. Newell to go ahead and develop into concrete plans many of the things he has suggested in his address.

VICE-PRESIDENT GOSSARD: I think most of us have the feeling that President Newell is so experienced along these lines of executive work that we cannot add very much. In fact, so much of his position is fundamentally sound and is sort of axiomatic, that no one feels like adding to it or subtracting from it.

PRESIDENT WILMON NEWELL: We will now proceed to the program. Subject to the approval of the association, the practise concerning papers will be as follows:

The time limit given to each paper on the program will not be extended, except by vote of the association. If the author is not present when a paper is called, the paper will be deferred to the end of that session, and if time permits, all such deferred papers will be called in order, but they will not be carried over to the beginning of the next regular session. Unless the association directs otherwise, papers sent by absent members will be read by title only.

First paper is entitled "A Volunteer Pest Reporting Service," by S. B. Fracker, Madison, Wis.

## A VOLUNTEER PEST REPORTING SERVICE

By S. B. FRACKER, *Madison, Wis.*

One of the problems of every entomologist whose field of work includes assistance in the control of insect epidemics is that of securing adequate information in time to be of value. This is particularly true in the case of the less conspicuous insects, although even when outbreaks are so

serious as to result in complete destruction of certain crops, the damage may be extensive before reports are received.

The larger the state and the greater the variety of crops grown, the more serious is this problem. Nevertheless it seems to be a custom in entomological departments to rely on occasional or emergency calls from the farmers and growers affected. The problem is solved to some extent by the establishment of field stations with entomologists permanently located in various parts of the state, but this is beyond the resources of many departments and even when such stations can be established, as they are now in Illinois, each of them has as large a field to cover as two or three of the New England states combined.

It was with the double purpose of being able to assist in the control of insect outbreaks promptly and of securing adequate and permanent records which might at some future period help to solve the problem of periodicity in insect outbreaks and the relation of weather and climatic changes to these conditions, that the Wisconsin Department of Agriculture began the establishment of a voluntary pest reporting service this past season. Somewhat similar plans are in use, I believe, in New York and Tennessee. While the results are adaptable both to immediate use and permanent records, the present paper will be confined to the methods employed and the nature of information secured, rather than to the more practical results in the way of insect control during the current season.

## Organization

The methods employed in securing this information were based to some extent on those of the Bureau of Crop Estimates, and the results were in fact correlated with the state work of the latter organization. The Bureau secures reports from the fifty or sixty counties on crop and weather conditions each week. One of the questions asked each correspondent is to name any insects or plant diseases which may be destroying or injuring crops in his vicinity. The reports are of course very brief and entirely inadequate from the entomological standpoint, but are of considerable assistance in determining the localities in which grasshoppers, and, in Wisconsin, the various potato insects are causing the greatest injury.

For the pest reporting service itself a list of probable reporters was worked up from the membership of the principal agricultural associations, such as the grain growers, known as The Wisconsin Experiment Association, the fruit growers and market gardeners in the horticultural society, graduates of the agricultural college who had taken a course or two in entomology, together with selected potato and tobacco growers, lists of which are also available. It was felt that county agents were so

heavily worked that it would be best not to expect continued reporting from them, but information secured in each county, when it would be of value, was sent to the county agent with the names of the farmers or horticulturists giving the information.

As in crop reporting, two types of schedule are sent out. The first requests general information in regard to the insects affecting the principal crops listed in the blank. This results in information concerning a wide variety of insects and is particularly valuable for the field entomologists working on insect epidemics.

When certain insects become numerous or particular kinds of control measures are being tried out in various parts of the state, the second form of report is used, which is a special questionaire relating to a particular insect or control measure. This past season in Wisconsin such a questionaire was used in regard to the prevalance of army worms, the number of farms in the county which suffered loss, control measures most commonly used, and their effectiveness. With this same schedule was included a similar one referring to grasshoppers and another to potato leafhoppers. These special reports may in turn be of two types: one for wide distribution in which suggestions for control can be included and which can well be distributed to every member of an agricultural association or every grower of a particular kind of a crop. The second and more detailed type of special report blank need only be sent to forty or fifty correspondents in various parts of the state upon whose statements regarding dates of injury, adequacy of control, etc., particular reliance can be placed.

The results of the first season's trial in Wisconsin have been at least as good as was expected, but as the list of correspondents is worked over can undoubtedly be improved. The value of such reports for both of the purposes for which the service was established depends entirely on three points: First, whether the reports are received from a sufficient number of widely distributed growers; second, whether they are accurate and complete enough to be of value, and third, whether they are received with sufficient promptness for quick action.

The general reports asking for information on grains, potatoes, other farm crops, truck crops, orchards and small fruit were returned from forty-five out of seventy-one counties of the state. If we add the general information secured through the crop reporting service with respect to the common insects, we find that sixty-two of the seventy-one counties sent in information regarding pests.

A most valuable suggestion received from the Bureau of Crop Estimates was that of dividing the list of reporters and sending blanks on alternate weeks or fortnights. If there are four correspondents to the

county, a blank can be sent to one each week. The result is a series of weekly reports while each correspondent makes one out only once a month.

While the entomological report form did not refer to plant diseases, a considerable number of reports were received concerning rusts, smut, potato blight, and fire blight in apple trees, as well as occasional reports regarding other plant diseases. The reports in regard to rust are of particular interest with respect to the accuracy and promptness which can be expected. The first week in which rust was referred to by the correspondents sending crop reports, such information came from five counties confined almost entirely to the southern border of the state. The next week seven additional counties were included, only two of which were north of the center of the state. A week later, of the seven counties reporting outbreaks of rusts, five were in the extreme northern part of the state. This was followed by a series of weekly reports in which no reference to grain rust was made as harvest had been completed. The reports of the grasshopper epidemic were somewhat similar, altho the progress from south to north was not a feature of the grasshopper outbreaks, the epidemic being confined largely to the northern half of the state.

In all, twenty-five insects and half a dozen plant diseases were reported. Those of general farm crops were the grasshopper, armyworm, and cutworm epidemics, and the usual annual injury from white grubs, wheat-joint worms, and wireworms. In the case of both armyworms and grasshoppers immediate and timely assistance can be given. For the other insects the information was of greater permanent than immediate value.

Of potato insects the Colorado potato beetle was of course reported everywhere from June to the middle of August. Leafhoppers were reported in about fifteen counties, the counties being grouped from week to week in almost the same way as those reporting rust outbreaks. Flea beetles were reported more rarely.

Of the insects reported attacking fruit, namely, the codling moth, the plum curculio, cherry slug, and canker worm, the most interesting was the cherry slug which appeared for the first time in a commercial cherry producing section (Bayfield county) and did a great deal of damage. Most cherry orchards in the county had never been sprayed with arsenate of lead, as it was not necessary until this season. No representative of the department being in that vicinity, adequate assistance and information would probably not have been available to the large number of cherry growers in time if it had not been for the pest reports which began to come in at the very beginning of the attack by the slugs.

Of the smaller and less prominent crops, the following insects were reported and in each case an outline of the best developed control measures were sent to the reporter.—Strawberry weevil, crown borer, and leaf roller; pea aphis, turnip aphis, and melon aphis; onion maggot and onion thrips; cucumber beetles, cabbage worms, and corn ear worms.

With respect to accuracy and reliability, the reports vary, but considerable confidence could be placed in them in the case of the more conspicuous forms of injury. The tabulation of data from three different sources, namely, the crop reporting service, the newly established pest reporting service, and the work of the field men of the department showed that information from the three sources tallied very closely.

Omissions of serious insect injury were rare, only one case being of great importance. This was a cankerworm outbreak covering a couple of townships. As the cankerworms had practically disappeared by the time the first report blank was sent out, this omission is not surprising.

With respect to the promptness with which reports of insect and disease attacks were received, the principal value came in the case of progressive and long continued losses, such as those from grasshoppers and grain rust, for army worm attacks are usually so sudden, brief, and destructive in Wisconsin that reliance must be placed on county agents for control. They are the only ones who can reach the scene of the damage in time.

The cherry slug reports from Bayfield county mentioned above were fortunately received just at the beginning of the attack, a condition under which maximum assistance could be given.

The great need in work of this kind and the principal reason why pest reporting has scarcely ever been undertaken systematically is the lack of any adequate means of measurement of the injury. This problem has not been solved as yet and perhaps will not be.

If such a pest reporting service could be organized on a national scale, with the establishment of permanent records, a means of studying serious insect losses would be established which is not at all available at the present time. It is generally understood, for example, that extensive armyworm outbreaks have not occurred between the years 1900 and 1920 and that the present grasshopper outbreaks in the northern states have been threatening for about three years, but there are no official records from which a future student of problems of insect outbreaks will be able to secure such facts. The only insects upon which such data has been accumulated which could be used for this purpose so far as the writer has information are the chinch bug and the Hessian fly, and even in these cases they are not as complete as could be desired.

Within the state systematic pest reporting from all sections offers additional advantages in enabling immediate action to be taken by the entomological staff in the case of insect injury about which they have no previous information. It also enables them to send outlines of the life histories and control measures of the common insects to representative growers in every county, a feature which will result in as extensive and desirable a form of entomological education as could be worked out.

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PRESIDENT WILMON NEWELL: Is there any discussion?

MR. E. P. FELT: I believe a volunteer pest reporting service is of material value in assisting in the detection of recently introduced insects, though I cannot support this by facts. About 20 years ago, the speaker had a similar service and two of these voluntary observers, as we called them at that time, are now active, energetic entomologists. I do not know whether they started with the voluntary pest service or not, but one of the things that we need to develop throughout the country is a more general appreciation of scientific work and more general cooperation, not only on the part of entomologists, but agriculturists, foresters, and laymen in general. We must secure the sympathy and cooperation of the latter, and in doing that, we will immensely increase our efficiency. I believe this is an activity that has not been given sufficient attention in many places.

MR. W. E. HINDS: I would call attention to the Mexican Bean Beetle situation in Alabama as an instance where a voluntary pest reporting service failed. This insect came to the attention of a county agent in Alabama a year before it was reported to the Experiment Station, because he failed to appreciate its importance. He recognized the insect and had some printed information concerning it, but failed to report.

MR. W. R. WALTON: I have had considerable experience with voluntary crop pest reporting service. A great many of the Federal reports are received in the Bureau of Crop Statistics and are referred to our office. They are usually 30 days late and do not give information quick enough to be of material use.

PRESIDENT WILMON NEWELL: The next is a joint paper by H. A. Gossard and T. H. Parks, on the "Value of Entomological Service to the Ohio Farm Bureaus in Their Efforts to Control the Hessian Fly."

## HESSIAN FLY PREVENTION

By H. A. GOSSARD and T. H. PARKS

For many years, the standard recommendation of entomologists to prevent Hessian fly injury has been to seed late. All have assumed the advice to be good and Hessian fly has been cited perhaps, more frequently

than any other insect as an illustration of what can be done by adapting agricultural practice so as to strike at the weak point in an insect's life history.

During the past few years, some entomologists have inquired somewhat further and have tried to find safe seeding dates for the different sections of our nation, basing them on the average dates determined through a series of years on observation plots seeded on different dates. However, for several years, some of the Ohio entomologists have greatly distrusted for fly prevention, the reliability of the seeding dates commonly depended on to secure a maximum yield and also to escape fly damage. They have, therefore, sought to find some more certain method of putting the young wheat beyond the reach of flies which sometimes decline to obey the schedules made out for them by the entomological brotherhood. The method devised has been used quite successfully during two different seasons to determine the best dates, but does not seem to promise constant and uniform success. Supplemented by the judicious use of other known methods it bids fair to prove valuable.

To discover the gradual approach of a Hessian fly outbreak has engaged our attention. Few entomologists in the field have had the opportunity and facilities to study this phenomenon and thereby obtain sufficient knowledge to certainly predict the visitation and hence, prevent it, or curtail in part the losses it would cause. The entomological workers of Ohio through the Annual Wheat Insect Survey, have determined such a means of forecast and have successfully used it to foretell and greatly to reduce the most serious outbreak the state has experienced for many years; viz, that of the fall of 1919.

## Preliminary Work of 1919

In the summer of 1917, the Ohio Experiment Station, as a war activity, organized the wheat survey. So much of promise seemed involved in its continuance, that each year since 1917, all of the entomological workers of Ohio State institutions have been called together to make the Wheat Insect Survey, the general direction of the work being shifted from one to the other of the State Entomological departments according to convenience. In July, 1919, this practice resulted in detecting the presence of the Hessian fly in threatening numbers. Since a progressive development of the pest was clearly indicated by the data gathered by this and the preceding surveys, a campaign for "safe seeding" was at once organized by the Extension Entomologist. This was conducted through farm bureaus and local, county, and state papers, circular letters, posters and community meetings, the effort being specially centered on northern Ohio. The seeding dates recommended were

those which had been generally accepted by our entomologists and agriculturists as safe in previous years.

## Result of the Late-Sowing Campaign of 1919

In the northern counties, probably nearly eighty percent. of the growers waited for the suggested dates before sowing. In the central and southern counties, about ninety percent. of the growers in counties having farm bureaus waited for the proper dates. The wisdom of this was seen in November, by which time the early sowed wheat all over Ohio had been destroyed by a very heavy fall brood of fly. Those who sowed before the dates suggested, everywhere suffered heavy and sometimes total loss. This is well illustrated by the yields obtained from the "date of sowing" plats on the Miami County Experiment Farm, which are here given:

| When Sowed | Percent. of plants infested Nov. 1919 | Yield in July 1920 |
|---|---|---|
| Sept. 8 | 100 | 16.5 bu. |
| Sept. 16 | 100 | 18.5 " |
| Sept. 23 | 100 | 12.5 " |
| Sept. 27 | 55 | 27.0 " |
| Sept. 29 | 10 | 37.4 " |
| Oct. 2 | 0 | 40.0 " |
| Oct. 4 | 0 | 37.8 " |
| Oct. 13 | 0 | 36.1 " |
| Oct. 20 | 0 | 21.6 " |

The seeding dates proved generally trustworthy for southern Ohio but not for northern, where wheat was damaged if sown as lateas September 26, or eight days later than recommended. By November, it was determined that there was a range of only five days in the departure of the fall brood from Lake Erie on the north to Cincinnati on the south, instead of 14 days, as should be the case, if it had obeyed the law of latitude. In southern Ohio less than 10 percent. of the wheat became infested, but 80 percent. is our estimate for several northern counties.

## Preliminary Work of 1920

During July, 44 counties were visited by the surveyors and the distribution of the spring and summer damage was found to conform to the previous fall infestation. The area of greatest density of infestation had moved from north-central to north-western Ohio. In one county, eighty-nine percent of all straws had been killed or damaged by the fly. On many of the best farms in northern Ohio the average wheat yield was not over eight bushels per acre, where in other years yields of 35 bushels had frequently been obtained. Many wheat fields were cut for timothy.

The survey showed that 44 percent. of all straws examined in the state were either killed or damaged by fly. Material was collected in

each county visited and sent to Wooster and to the Field Laboratory of the Bureau of Entomology at Lafayette, Indiana, to be examined for parasitism. No particular section of the state was found to be favored in the distribution of these parasites.

By August first, we were sure that the state was again threatened by serious fall damage, and another campaign of late sowing seemed necessary. This time it was not necessary to solicit the interest of the county agents nor of many of the farmers. The question most frequently asked was: "When shall we sow?" Uniform sowing dates had been decided upon by the entomologists working on this problem in Illinois, Indiana and Ohio, and these were given wide publicity in Ohio as the probable safe dates to sow to avoid both Hessian fly and winter-killing.

To supplement the sowing dates and better guide the growers of northern Ohio past the expected damage from the fall brood, the three entomological departments of Ohio arranged to establish three field observation points where the daily emergence and egg-laying could be watched during September. It was hoped in this way to be able to hold back sowing until the danger of the brood was past, if the dates previously chosen were again too early. To explain this plan, and also organize the counties in the worst infested area, the Extension Entomologist, during August, met with the crops committees of the farm bureaus in 19 of the north-western counties, as it was thought best to let these committees take the lead in the campaign work in their counties. A "fly meeting" was held in conference with these men, who at these meetings chose the earliest date they wanted any wheat sown in the county and outlined their plan to prevent wheat being sowed early this year. The county agents of these counties were instructed to keep in touch with the records from the rearing cages and egg-laying counts that were to be made by the entomologists, and have the organizations in readiness to further postpone the sowing dates if necessary. The committees in these counties conducted their own campaign. This was done through circular letters, meetings, daily press items, posters, and rubber stamps used on the mail of county firms doing business with farmers. Eight county agents had attractive exhibits of adult Hessian flies at County Fairs while the University featured this at the State Fair.

## Method for Discovering the Seeding Date

In the Journal of Economic Entomology, February 1916, pp. 142–144 a description was given of a new method used to determine the seeding date, and it will be remembered that Miami County, Ohio, was almost wholly freed from Hessian fly by one season's work. Substantially the same method was followed this season, but we endeavored

to make our breeding stations perform a statewide service and added some new types of cage or trap to either breed out flies or else to catch them in natural flight in the field. The three most practical were named and defined as follows:

1. Concentration cage. This was a tight store box without bottom and with circular holes cut in the top for lantern globes fitted into them, the globes being covered over the top with cheese-cloth tied in place. Into this cage was put about two bushels of stubble and surface earth known to contain healthy "flaxseeds" in great numbers. If the stubble and earth heap was not moist, this was or should have been wetted with one or two pailsful of water, because this loose heap dries out more rapidly than field soil, and normal conditions are more nearly preserved by adding the water. Water was also added as each rain occurred.

2. Migration wire. Five linear feet of ordinary wire fly-screen, two or three feet high, was set up on a frame with the lowest edge elevated about eight inches to one foot above the ground and standing north and south. A similar trap was set at right angles to it, east and west. By this arrangement the chance for catching flies was equally good no matter from which direction the wind blew. The wire was coated with tanglefoot, the flies removed with a brush after each day's count, and the tanglefoot renewed or freshened by brushing over it.

3. Egg Record. Besides the traps just described, a strip of wheat was seeded at each station in time to be of inviting size at the date when the flies were expected to appear. A number of these plants were so marked that they could be identified easily, and when the flies began to appear all eggs were counted and removed. Each day, thereafter, the eggs were counted and removed.

The records of fly activity at one of the four stations were registered by these devices as follows:

HESSIAN FLY RECORD * * * 1920, SANDUSKY, OHIO

| | September | | | | | | | | | | | | | | | | | | | | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dates<br>Kind of cage | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 1 |
| Concentration ...... | 3 | 2 | 4 | | | 6 | 10 | 11 | 34 | 87 | 129 | 161 | 152 | 72 | 76 | 43 | 18 | 37 | 2 | 0 | 1 |
| Migration .. | | | | | | | | | 2 | 127 | 201 | 268 | 99 | 65 | 44 | 82 | 48 | 38 | 8 | 3 | 0 |
| Totals .... | 3 | 2 | 4 | | | 6 | 10 | 11 | 36 | 214 | 330 | 429 | 251 | 137 | 120 | 125 | 66 | 75 | 10 | 3 | 1 |
| Eggs counted on 100 plants | | | | | | 192 | 66 | 96 | 37 | 475 | 1247 | 1577 | 458 | 193 | 253 | 158 | 69 | 34 | 24 | 10 | |

While stations were also maintained at Bryan, Wooster and Columbus, the brood at the last two points was much lighter and results were not pronounced. For these two points, we were obliged to fall back on

our old seeding dates, but felt more sure of them after having the data from Bryan and Sandusky. We found that for the successful management of an emergence station the entire time of one entomologist is required.

We had meetings at both Bryan and Sandusky of farmers and county agricultural agents, and after showing them our equipment and the results, agreed with them on seeding dates. While the migration wire and the egg counts seemed to give the truest record regarding the activity of the brood, the concentration cage was the best asset from a psychological standpoint to gain the attention and support of the county agents and farmers. When they could see a swarm of flies which had emerged within the preceding 24 hours in the glass globe, and found this record supported by egg counts and the catch of the migration wire, they were readily convinced that wheat exposed to attack would certainly suffer. The other types of cage gave valuable information regarding density of emergence and furnished a check on the concentration cage, the migration trap and egg-laying records. From them we knew that emergence in the concentration cage was nearly normal, not lagging more than a day or two behind that in the cages with field conditions.

After the experience in Miami County in 1915 and this season's experience, we feel confident that if, in years of Hessian fly abundance, a half dozen competent entomologist are stationed at six fly-emergence stations in selected localities over our state, we can determine from their observations favorable seeding dates for different sections with about as much certainty and precision as the United States Weather Bureau can predict the weather. While some of the records may prove indecisive, others are likely to give a clear record, assisting greatly in determining the trustworthiness of the seeding dates usually followed. We concede that the date, thus found, may be a few days later than the best date for maximum yield, but this latter can hardly be established for years with heavy infestation, and we, therefore, favor finding the safest date it is possible to discover.

## Result of Late Sowing Campaign of 1920

The daily emergence and egg-laying records were wired or mailed to the county agents in the counties it was desired to guide, and it was found necessary to delay seeding several days longer than the dates at first selected to sow by some of these county farm bureaus. On September 25th, the emergence and egg-laying had subsided greatly at Bryan, and two days later at Sandusky. Analyses made of "flax-seeds" in the old stubble showed that most of the flies had emerged.

A considerable number, which had not emerged, contained Hessian-fly larvae which apparently would not emerge until spring. The word was given to Williams and surrounding counties to sow wheat after the 27th. For Erie and surrounding counties, October 1st was the date selected. On September 28th, many drills were starting in the north-western counties, though some chose to wait a little longer.

The result of the extension effort was indeed gratifying, and the response almost unanimous. Less than one percent. of the wheat had been sowed before the final dates chosen. In many townships not an early sowed field could be found. Seeding proceeded promptly during the first ten days of October. At no point were many Hessian-fly eggs found from September 30th until October 14th. The young wheat had escaped a very heavy infestation and was looking well. The little early-sowed wheat that could be found, in most counties, had become heavily infested with the fall brood soon after it came up.

## October Egg-laying

An unexpected appearance of adult flies during mid-October over all except north-eastern Ohio, resulted in many eggs being deposited between October 14th and 19th. This emergence was over by October 20th. Wheat which came up too late to become infested by the main fall brood, then became infested with eggs, and later with the maggots of the fly. At Columbus 802 eggs were deposited upon 100 plants kept under observation during that time.

Proof was obtained that this late wave of emerging adults came from flaxseeds which developed during June on the main crop. Hence they did not represent a true supplementary brood, but came from "hold-over" flaxseeds which did not give up their occupants during September as previously observed. This "holdover" stock of summer flaxseeds was exceedingly large, and only a part of them gave up adult flies during October. The remainder are carrying their occupants, doubtless to enhance the numbers of the spring brood. Instead of emerging in September, the fall broof of 1920 divided into three parts as follows: 1—September emergence of the normal fall brood. 2—Mid October emergence or "late wave." 3—"Carry over" flaxseeds still unemerged in midwinter.

The maggots which hatched from the eggs deposited by the late wave adults grew quite slowly, and caused some damage to all wheat above ground before October 16th. About 20 percent. of these plants became infested.

Thus, by an eleventh hour effort, the Hessian-fly prevented what looked to be a complete and statewide control as the result of the united

effort of the growers. The damage from the late wave of October flies is considerable, but insignificant when compared with the result of the visitation of the main fall brood of 1919, the like of which the farmers of Ohio missed in 1920 by pulling all together.

## Summary

Summarizing the Ohio work we believe we are justified in claiming:

First, that an annual entomological wheat survey just before harvest, such as Ohio has maintained for four seasons, will reveal an approaching outbreak of Hessian fly and prevent surprise.

Second, that several fly emergence stations located at selected points over the state will furnish the most dependable data obtainable upon which to base recommendations for safe seeding dates for the different localities. If some or all of the emergence stations fail to yield decisive results, the sowing dates established by plot tests through a series of years should be used to guide the sower.

Third, that a well organized extension service cooperating with the county farm bureaus can get the recommended dates for seeding into the hands of the farmers within 24 hours or less after they are determined from the emergence records. And, futher, that by energetic preliminary work the Extension Entomologist can secure the ready cooperation of 99 percent. of the farmers in a seeding campaign.

Fourth, that as a result of our annual surveys and correlated efforts, a threatened heavy brood of fly has been kept suppressed, and that there will be twice as many bushels of wheat in Ohio in 1921 as would have been the case, had we given the insect no attention.

Mr. W. P. Flint: The experiences stated in this paper are about the same as those we have had in Illinois this year, particularly concerning the great variation in the actual fly-free dates. From 1918 to 1920, the dates varied 22 days at Champaign, Ill.

Mr. J. J. Davis: My recent observations in southern Indiana indicate that the late wave of fly is still in the larval stage and very likely these larvae will not mature and not issue next spring.

Mr. T. H. Parks: The change from the larva to the flaxseed stage in Ohio has been very recent. Three weeks ago there were very few in the flaxseed stage in southern Ohio, but now over half of them are in that stage.

Mr. H. A. Gossard: Three-fourths of them are in that stage in northern Ohio.

President Wilmon Newell: The next paper entitled "The Potato Leafhopper and Tarnished Plant Bug in 1916," will be presented by Mr. S. Marcovitch.

# THE POTATO LEAF-HOPPER AND TARNISHED PLANT BUG IN 1916

By S. MARCOVITCH, *Knoxville, Tenn.*

Ball records in this JOURNAL a severe epidemic of the potato leaf-hopper on potatoes in Wisconsin for the summer of 1918. In a series of splendid experiments he also proves that the causative agent is the potato leaf-hopper, *Empoasca mali* Le B., and not the so called tipburn.

The writer had reached the same conclusion during the summer of 1916 when connected with the Minnesota Experiment Station. The results were published in the Princeton Union August 24, 1916, describing "havoc in the potato fields," in the vicinity of Princeton. Minnesota. Mr. Saxon a potato farmer in Princeton, called our attention to the hoppers. It was only his insistence that the bugs were the cause of the damage, that caused more accurate observations to be made. As far back as 1911, Mr. Saxon reports that he noticed the leaf-hoppers injuring his potatoes, causing as much as 35 per cent. damage. Several weeks in the field were devoted to studying and experimenting with hopper-dozers and spraying.

In Minnesota, the Triumph variety suffered most severely. The leaves were dying so rapidly that a perceptible decaying odor could be smelled. From 350 to 500 leaf-hoppers and about 50 tarnished plant bugs were counted on a single vine. In addition to the regular potato leaf-hopper, *Empoasca mali*, there were also present in some numbers two other leaf-hoppers, *Deltocephalus inimicus* and *Cicadula 6-notata* as well as a large brown *Drosophila*, probably attracted by the decaying odor. It was noted that the leaf-hoppers suck on the small veins causing the leaf to curl along the margin while the tarnished plant bugs suck on the midrib or the tip of the growing shoot causing the leaf to curl upwards or the shoot to wilt entirely. If the stem of a shoot that has been stung by the tarnished plant bug is cut open, it will be found to be rotten. Very often a distinct swelling can be noted on the stems. Later varieties, such as the Burbank, did not suffer badly probably because they are not so tender as the Triumph, or as Ball observed that not enough foliage is present for egg deposition of the spring brood. During the early part of September wet rainy weather set in. The leaf-hoppers promptly disapppeared and many were noticed clinging to leaves, having been attacked by a fungus. Observations were made on early Ohios in the western part of the state in the vicinity of Moorhead. No burning was found and but very few leaf-hoppers were noticed. The season was wet there and this probably accounts for their absence.

The work in regard to the control consisted in running a hopper-dozer over 20 acres of potatoes. Both kerosene and tanglefoot were

used for the catching mediums. A great many leaf-hoppers were caught but figuring 400 to a plant we caught probably one percent. The hoppers would fly over the machine and under and at times the driver could hardly see his way thru the cloud of insects dancing over the machine. Our work, at best, demonstrated the utter uselessness of the hopper-dozer for the control of the potato leaf-hopper.

Spraying experiments were also carried out using kerosene emulsion. A 15 to 1 emulsion gave no results, neither did a 10 to 1. The only thing we could get to kill them was a 2-to-1 or pure, kerosene. The latter two did not injure the vines. When Professor Moore learned that we had used pure kerosene without injury to the plants, he set out to determine the cause and gave us his results (JOUR. ECON. ENT. 11:70) showing that kerosene is a very variable product in regard to boiling points and toxicity.

It was planned to make further cage experiments such as Ball did to prove absolutely and beyond doubt that the leaf-hopper is the cause of the burning of the potato leaves, but the writer left Minnesota to enter another field shortly afterwards.

PRESIDENT WILMON NEWELL: The next three papers bear on the same subject. If there is no objection, discussion will be deferred until their reading has been completed.

The first is by Mr. Albert Hartzell on "Further Notes on the Life History of the Potato Leafhopper."

## FURTHER NOTES ON THE LIFE HISTORY OF THE POTATO LEAFHOPPER

(*Empoasca mali* Le Baron)

By ALBERT HARTZELL, *Iowa State College, Ames, Iowa*

Dr. Ball's[1] discovery that the potato leafhopper is responsible for the disease called tipburn was the first step in removing the subject from conjecture and directed serious attention to the study of the insect as the key to the solution of the problem. Little was known regarding the life history of this species because of the difficulty experienced in keeping the adults and nymphs in captivity a sufficient length of time to rear a complete generation. For the last two years the Iowa Experiment Station has been conducting a study of this insect and as some of the first year's work has been published[2] it is the purpose of this discussion to give only a brief summary of additional information obtained during the growing season of 1920. The work was done under the direction of

[1]Ball, E. D., Wis. Dept. Agr., Bull. 23, pp. 76–102, 1919.
[2]Fenton, F. A., and Hartzell, A., JOUR. EC. ENT., Vol. 13, No. 4, pp. 400–408, 1920.


1, Swelling on stem caused by the tarnished plant bug; 2, Leaf curled along midrib caused by the attack of tarnished plant bug; 3, Leaf showing midrib dying, caused by tarnished plant bug; 4, Stem gnarled as a result of many punctures of the tarnished plant bug.

Dr. F. A. Fenton to whom the writer is indebted for suggestions and criticisms. Mr. I. L. Ressler and Mr. Carl Knapp assisted in conducting some of the experiments.

## Methods

Because of its small size, protective coloration and activity, the potato leafhopper required the development of special technique in order to keep the insect under observation for a sufficient length of time to determine its life cycle. The cage that proved most successful in our work consisted of a large lantern globe with the top covered by means of a very fine screen (20 meshes to the inch) soldered on a galvanized collar made to fit tightly against the top of the globe. By plugging the rim with cotton a very tight and serviceable cage could be had and since the cage was large enough to cover a whole potato stalk it approximated field conditions better than any other device we were able to use. The lantern cages were placed in an out-door shelter which was similar to those used generally in life history work and the results checked up with field observations and experiments.

As the adults are very small and active, difficulty was experienced in transferring them from one cage to another in order to supply them with fresh food plants. To alleviate this a special dark room was built provided with a small window tightly screened. In order to make the darkness more intense the walls were painted black. If lost in transferring, the adults could be recovered because they are positive phototrophic. By means of this device it was possible to make frequent transfers without undue loss of time and the minimum danger of the adults escaping.

## Climatic Factors

The season of 1920 was unusual in that the average temperature was considerably lower than normal. The maximum temperature at no time exceeded 95 degrees F. at Ames, while during the previous summer a constant high average was maintained from the middle of June until the first week in August with the maximum reaching as high as 100 degrees F. The summer of 1919 was dry and hot as contrasted with a cool, late season this year. The fore part of the season was at least three weeks later than last year and the low average temperature was unfavorable for the development of the leafhoppers. That the insect reaches its optimum development during hot, dry weather has been noted by other workers and was in evidence this season by the large number of adults and nymphs appearing during the last week in July.

## Seasonal History

The potato leafhopper overwintered in the adult stage. A few females were found early in May on curly dock and other weeds. In

spite of the fact that practically no males were captured at this early date, the females were fertile and ready to lay eggs. This was brought to our attention by the appearance of first instar nymphs on early planted potatoes June 15, indicating that oviposition was under way by the first week in June. The spring flight occurred June 27, which was three weeks later than last year. Prior to this the females greatly out-numbered the males but after the flight the sexes were approximately equal. The early appearing females completed egg laying and died the first week in July, while individuals captured at the time of spring flight continued to live until the first week in August. One over-wintering female died August 27 after having spent 59 days in captivity.

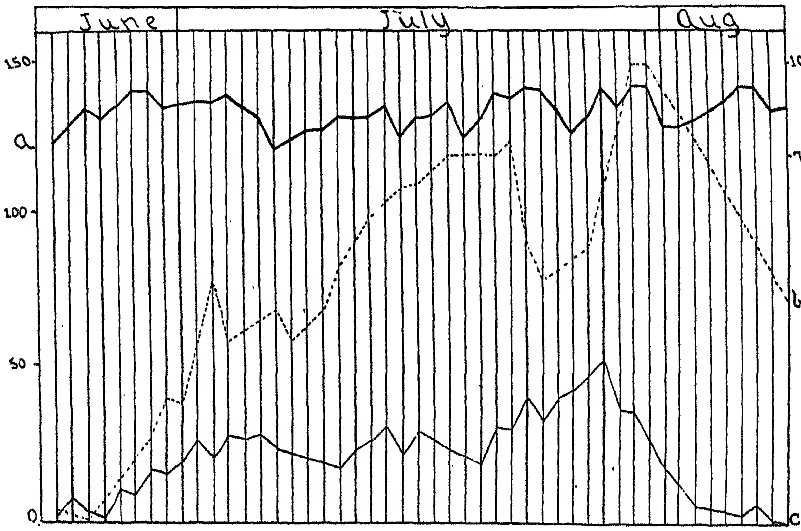


Fig. 1. Curves showing leaf-hopper population correlated with temperature: *a*, Maximum temperature at Ames; *b*, Adults; *c*. Nymphs.

The number of young produced by the early appearing individuals was approximately one-half the number produced by females captured at the time of the spring flight. The nymphs of the last appearing females reached maturity at a correspondingly late date. These observations and experiments convinced the writer that the overwintering females represented a mixed population. The females appearing out of hibernation early in the spring were probably the remnant of the summer generation of the previous season that had emerged too late to complete egg laying and had survived the winter to finish it this year. The absence of males in the fore part of the season and the low fecundity could be accounted for in this way. On the other hand it would follow that the adults appearing at the time of the spring flight were individuals

of last year's second generation, the males and females of which are able to survive the winter in equal proportions.

Adults of the summer generation emerged during the first week in July from nymphs reared from early appearing females, while nymphs hatched from eggs laid by females at the time of the spring flight did not reach maturity until the middle of the month. Adults of the second generation emerged about the middle of August.

With the exception of the overwintering individuals all the females used in our experiments were reared from nymphs so that the generation to which they belonged could not be open to question. The life cycle this season consisted of one complete generation and a partial second. The lateness of the season, the cool, rainy weather during May and June were contributing factors in retarding the development of the leafhopper this year. Experiments conducted by Dr. Fenton under control termperatures indicate that the potato leafhopper requires a very high average temperature for optimum development. Field counts of nymphs indicated that the number of leafhoppers appearing this year was probably a little more than half the number hatching last year. The killing frost this season occurred earlier than last year but was followed by a period of warm weather and the summer generation females continued to oviposit until the middle of October.

## Leafhopper Population

In order to obtain an index to the number of adults on the potato vines on a given date, sweepings were made daily throughout the season. A plot of Early Ohios was selected which was not sprayed so that it represented normal conditions. In making the counts an ordinary insect net was used. Twenty strokes of the net were made while walking along the rows and the number of adults captured were counted. In order to reduce the error to a minimum these counts were made by the same person, and the weather permitting, at the same hour daily. The results of the field counts show that the overwintering adults appeared in maximum numbers the first week in July, from that time on the steady rise in the curve is due to the overlapping of the summer generation. By the last week in July most of the overwintering adults had died.

Field counts of the number of young hatching each day were made on early potatoes. Six branches from as many hills were selected and labelled and the number hatching daily were counted and killed. A total of 1077 nymphs hatched on the vines and the possible number per acre would run between five and six millions. The maximum number of nymphs hatched the last week in July indicated that the largest number of eggs were laid during the middle of the month. The field counts

were discontinued in August because by that time practically all the plants were dead from tipburn.

Summer generation adults did not appear in any numbers until the last week in July when they migrated to the late potato fields where they began depositing eggs. Careful field counts of the number of young hatching were made, but the second brood was insignificant as compared to the first. The development of this generation was no doubt influenced to some extent by the death of the vines during the latter half of August. The remaining adults migrated to curly dock where they remained until frost. Nymphs in all stages were found on curly dock as late as October 28, when a freeze occurred in which all of the nymphs and most of the summer generation adults perished. After this host failed them the remaining adults entered into hibernation.

## Longevity

That the overwintering adults live longer than was supposed is shown by the fact that the females lived an average of 36 days in captivity, depositing eggs as late as the last week in August. This would indicate a total length of life of at least twelve months.

Table I.—Cage Records of Overwintering Females Captured Prior to the Spring Flight

| | Date Female Introduced | Date of Death | Days in Captivity | Average |
|---|---|---|---|---|
| 1 | June 19 | July 15 | 26 | |
| 2 | June 18 | July 6 | 18 | |
| 3 | June 10 | July 6 | 26 | |
| 4 | June 17 | July 6 | 19 | |
| 5 | June 17 | July 6 | 19 | 21.6 days |

A comparison of Tables I and II shows that the females introduced after the spring flight lived much longer than those captured early in the season.

Table II.—Cage Records of Overwintering Females Captured After the Spring Flight

| | Date female introduced | Date of death | Days in captivity | Average |
|---|---|---|---|---|
| 1 | June 29 | Aug. 27 | 59 | |
| 2 | June 29 | Aug. 9 | 41 | |
| 3 | June 29 | July 29 | 30 | |
| 4 | June 29 | July 20 | 21 | |
| 5 | June 29 | July 29 | 30 | 36.2 days |

Contrary to the general belief all the females of the summer generation are not killed at the time of frost. One female of this brood lived from August 3 to December 6, a period of 124 days, while the average longevity of five individuals was approximately 100 days. The results of this year's study indicate that some of the females of the summer generation overwinter.

Table III.—Longevity of Summer Generation Females

| | Date female emerged | Date of death | Length of life in days | Average |
|---|---|---|---|---|
| 1 | Aug. 3 | Dec. 6 | 124 | |
| 2 | July 10 | Oct. 27 | 109 | |
| 3 | July 29 | Oct. 30 | 93 | |
| 4 | July 7 | Oct. 8 | 93 | 100.4 days |
| 5 | July 7 | Sept. 28 | 83 | |

## Oviposition

Owing to the minute size of the egg and its concealment in the plant tissue, it is impossible to make egg counts. In order to determine the number of fertile eggs, potato plants were exposed to females for seven day periods and the number of nymphs hatching noted. The plants used in this experiment were grown in the greenhouse where they had been free from exposure to leafhoppers.

From June 21 to September 6, for a period of seventy-seven days first generation nymphs were hatched from eggs deposited by overwintering females. Nearly twelve weeks elapsed from the time the first nymphs hatched until the last ones appeared in the cages from these overwintering individuals.

Table IV.—Number of Nymphs Hatched from Eggs Deposited by Overwintering Females Captured After Spring Flight

| | Date introduced into cage | First nymph | Last nymph | No. days from 1st to last nymph | Total nymphs |
|---|---|---|---|---|---|
| 1 | June 29 | July 8 | Aug. 12 | 35 | 62 |
| 2 | June 29 | July 8 | Sept. 6 | 60 | 142 |
| 3 | June 29 | July 7 | Aug. 9 | 33 | 66 |
| 4 | June 29 | July 8 | Aug. 7 | 30 | 107 |
| 5 | June 29 | July 8 | Aug. 18 | 41 | 62 |

The females introduced into the cages prior to the spring flight averaged 34 nymphs, while those introduced after the flight average 88 nymphs. It appears that the early appearing females had laid part of their eggs the previous summer before going into hibernation. The maximum number of nymphs reared from eggs deposited by a single individual was 142. This record was obtained from a female captured at the time of the spring flight. This female also holds the longevity record for overwintering individuals, living until August 27.

The early appearing nymphs of the summer generation hatched in our cages July 30 but did not appear in any numbers until the middle of the month. The last nymph of this series hatched October 22 but young were collected on curly dock as late as October 28. Thus the oviposition period extended from the middle of July to the middle of October for this season. The greatest number of nymphs reared from eggs deposited by a single female of the summer generation was 59 as

compared with 142 nymphs reared from a single female appearing at the time of the spring flight.

Experiments were conducted to determine what time of the day the eggs are laid. Potato plants in large pots were exposed daily during the egg laying season and a careful count of the number of nymphs hatching noted. The plants were carried to a near-by potato plot and left there for twelve hour periods. When not in use they were kept free from exposure to the adults. Plants exposed from 5 p. m. to 9 a. m. hatched the greatest number of nymphs, which indicated that oviposition occurs for the most part at night.

## Host Plants

In order to determine whether or not a complete generation could be reared on some of the plants upon which *Empoasa mali* had been observed feeding, a number of experiments were conducted with curly dock (*Rumex crispus*), Carolina poplar (*Populus alba*), pig weed (*Chenopodium album*), and broad leaf plantain (*Plantago major*). All of the above gave negative results except curly dock from which a complete generation was reared. In addition to curly dock the potato leafhopper has been bred on apple, bean and potato. The writer has collected nymphs from Carolina poplar, sumac (*Rhus hirta*), rhubarb, hollyhock and dandelion. It is possible that the adults feed somewhat promiscuously and may oviposit in plants that are unable to sustain the young, but the supposed long list of host plants may have to be reduced. Strangely enough we have never collected nymphs from broad leaf dock (*Rumex obtusifolius*).

The importance of curly dock as a wild host was brought forcibly to our attention by the death of the late potato vines in August. Adults and nymphs were found on these plants until frost and it is probable that this host may serve as a connecting link between late potatoes in the fall and early potatoes in the spring. The plant affords a very succulent growth and is one of the earliest to appear in the spring and is very resistant to frost. The importance of this weed as a host plant is worthy of further study.

President Wilmon Newell: The next paper is by Mr. John R. Eyer, on "The Influence of Leaf-hopper Control on Potato Yields."

# THE INFLUENCE OF LEAF HOPPER CONTROL ON POTATO YIELDS

By J. R. Eyer, *State College, Pa.*

During the past two years comparative tests of different insecticide and fungicide combinations have resulted in the conclusion that Bordeaux Mixture with excess lime or other materials to form a wash of heavy consistency, with or without the addition of Nicotine Sulphate, is most effective in preventing the phenomenon known as "Hopper burn."

In Wisconsin, Ball and Dudley obtained satisfactory results with Bordeaux and Bordeaux-Nicotine sprays. In New York State, Parrott and Olmstead have controlled hopper burn by Bordeaux-Lime washes, although some foliage injury resulted from these heavy lime sprays.

Dr. Ritzema Bos, experimenting in Holland, demonstrated the reduction of potato foliage-burning by Bordeaux-Lime sprays, and also noted an appreciable decrease, during cloudy seasons, in the tuber production of sprayed plants. His experiments support the conclusion that, during sunny periods, the Bordeaux Mixture has a beneficial effect on healthy plants due in a large part to the shading it produces. During cloudy seasons, however, this shading decreases the potato yield.

This paper presents the details of two years experiments, conducted under field conditions in Erie County, Pennsylvania. These tests were made with especial reference to the control of hopper burn, and to the effect of such sprays on tuber production. It is interesting to note that there were but thirty-six sunshiny days in Erie County during the potato growing season of 1919 and forty-five during the season of 1920. According to Professor Muncie, our Pathologist, late blight did not factor in the results of the spraying experiments for either season.

The experiments of 1919 indicated that Bordeaux Mixture produced a fair control of hopper burn and increased the yield twenty-nine bushels per acre. On the other hand, while Bordeaux-Nicotine sprays decreased the percentage of hopper burn, these plots produced only one bushel more potatoes per acre. Bordeaux-lime (4–8–50) controlled hopper burn more effectively than either of the above sprays, but the yield was twelve bushels below that produced by Standard Bordeaux Mixture.

On the basis of these results, more extensive experiments were outlined for 1920. Comparisons were made using hand and power sprayers. These tests clearly indicated that there was a difference in relative control of hopper burn and in yield due to the method employed. These factors are considered in discussing the efficiency of the several sprays. Table I presents the data obtained from hand-sprayed plots treated with

Bordeaux-Lime and Bordeaux-Nicotine combinations. Table II presents similar data from machine-sprayed plots.

As in 1919, Bordeaux 4–4–50 produced a normal increase in yield. In hand sprayed plots 4–8–50 and 4–12–50 combinations produced yields often lower than their respective checks, even though hopper burn was decreased to four per cent. In machine-sprayed plots, each of these combinations produced less tubers than Bordeaux 4–4–50. Milk of Lime 8–50 controlled hopper burn fully as well as Bordeaux 4–8–50, but produced no increased yield. Kaolin added to Bordeaux 4–4–50 was not so effective as Bordeaux 4–8–50 in hopper burn control, and decreased the weight of tubers to about the same extent as the latter.

Other tests were made with Bordeaux-Lime-Nicotine and Nicotine-Soap combinations. Bordeaux-Nicotine sprays were quite effective in controlling leaf hopper, and reduced hopper burn to three per cent in hand-sprayed plots. On the other hand the yields were only slightly above Bordeaux 4–4–50. Bordeaux 4–8–50-Nicotine was superior to the 4–4–50-Nicotine combinations. Lime-Nicotine wash averaged less than 4–4–50 Nicotine mixture in tuber production, and was not so effective in control of hopper burn. Plots sprayed with Nicotine soap solution produced almost as many tubers as plots sprayed with Bordeaux 4–4–50, but hopper burn was more in evidence.

In all the tests Bordeaux sprays with excess lime effectively controlled hopper burn, but, as shown by Ritzema Bos, the shading effect of these washes materially decreased the potato yield. In plots sprayed with Bordeaux-Nicotine, the hopper burn was reduced to a minimum, but in each case the yield was only slightly above standard Bordeaux. In view of the fact that there is an added cost of $5.40 per acre in Nicotine sprays, with a corresponding average gain of but six bushels more per acre than with standard Bordeaux, is it not logical to question the economy of attempting the control of hopper burn in regions where there is comparatively little sunshine during the growing season?

TABLE I.—HAND SPRAYED PLOTS

| Materials | Kind of Potatoes | Amount of Tipburn: Treated percent | Amount of Tipburn: Check percent | Yield per Acre: Treated bu. | Yield per Acre: Check bu. | Average Increase per Acre |
|---|---|---|---|---|---|---|
| Bordeaux Mixture 4-4-50 | Early | 12 | 25 | 142 | 136 | 6 |
| | Late | 28 | 60 | 126 | 122 | 4 |
| Bordeaux Mixture 4-8-50 | Early | 10 | 25 | 144 | 148 | -4 |
| | Late | 10 | 60 | 122 | 122 | 0 |
| Bordeaux Mixture 4-12-50 | Early | 4 | 25 | 137 | 150 | -13 |
| Milk of Lime 8-50 | Late | 34 | 70 | 90 | 89 | 1 |
| Bordeaux Mixture 4-4-50 and | Early | 10 | 25 | 156 | 150 | 6 |
| Nicotine 1-800 | Late | 7 | 60 | 108 | 89 | 19 |
| Bordeaux Mixture 4-8-50 and Nicotine 1-800 | Late | 3 | 60 | 134 | 122 | 12 |
| Milk of Lime 8-50 and Nicotine 1-800 | Late | 24 | 60 | 124 | 122 | 2 |
| Nicotine and Soap | Early | 13 | 25 | 148 | 143 | 5 |
| | Late | 50 | 60 | 126 | 122 | 4 |

TABLE II.—MACHINE SPRAYED PLOTS

| Materials | Kind of Potatoes | Amount of Tipburn Treated percent | Amount of Tipburn Check percent | Yield per Acre Treated bu. | Yield per Acre Check bu. | Average Increase per Acre bu. |
|---|---|---|---|---|---|---|
| Bordeaux Mixture 4-4-50 | Late | 40 | 70 | 176 | 154 | 22 |
| | Late | 50 | 70 | 176 | 145 | 31 |
| Bordeaux Mixture 4-8-50 | Late | 28 | 70 | 176 | 165 | 11 |
| | Late | 28 | 70 | 175 | 145 | 30 |
| Bordeaux Mixture 4-12-50 | Late | 25 | 70 | 165 | 145 | 20 |
| Bordeaux Mixture 4-4-50 and Kaolin 60-100 | Late | 28 | 70 | 165 | 154 | 11 |
| Bordeaux Mixture 4-4-50 and Nicotine 1-800 | Late | 38 | 70 | 176 | 154 | 22 |
| Cage | Late | 28 | 60 | 203 | 152 | 51 |

PRESIDENT WILMON NEWELL: The last paper of this series is by Mr. F. A. Fenton, and is entitled "Further Experiments with *Empoasca mali* Concerning its Relation to Potato Tipburn."

## PROGRESS REPORT ON THE SEASON'S WORK ON THE PRODUCTION OF POTATO TIPBURN

By F. A. FENTON, *Iowa State College, Ames, Iowa*

During the past season experiments were continued in regard to the production of potato tipburn by the leafhopper, *Empoasca mali* Le Baron, and very interesting and significant data were obtained. These tests were conducted to determine the effect of artificial mutilation on the potato leaf, the result of colonizing leafhoppers on the plant foliage under different environmental conditions, the comparative effect of different stages of the insect on the leaves, the injury other insects might produce, and the effect of Bordeaux mixture on the leaf-hoppers.

### EFFECT OF ARTIFICIAL MUTILATION ON POTATO LEAVES

In the first experiment the leaf veins or leaf petioles were mutilated with various instruments. These tests consisted in puncturing the mid-vein with "*minuten Nadeln,*" with finely drawn glass thread, with blood dropper, and with the ovipositor of a hymenopterous insect. The mid-vein was also severed in different places with a scalpel. Individual leaves were mutilated once, twice and three times with the above instruments, which were not sterilized. When the leaves were punctured, little or no injury resulted, but when the mid-vein was severed, the leaf showed a distinct type of injury. This was first observed after a period of nineteen days when a triangular area at the tip of the leaf turned yellow and then brown, a condition identical with that of beginning tip-

burn. However, this dead area was comparatively small and confined to the extreme apical portion of the leaf. Furthermore, it did not increase in size in spite of the fact that the mid-vein was completely severed in as many as three distinct places.

## Influence of Environmental Factors—Cage Experiments

July 29th a second series of tests was conducted in the greenhouse to determine the effect of the potato leafhopper on the plant under different environmental conditions of soil, humidity, and sunlight. These potted potato plants (Early Ohio variety) were all healthy and were caged with an equal number of leafhoppers, 50 adults and 50 nymphs being added to each cage. Daily observations were made and careful examinations conducted on August 6th and 10th, respectively, the experiment being closed on the latter date.

One series of plants growing in sand and another in loam were kept on a bench where they were in direct sunlight during the greater part of the day. Individual plants in each series were caged with leafhoppers. Burning began within twenty-four hours on those exposed to the insects and increased daily until they were badly injured at the close of the experiment. All check plants remained perfectly normal throughout the test. Potato vines growing in loam burned just as badly as those in sand, the type of soil having little or no influence on the final results.

In the second phase of the experiment one series of plants growing in loam were placed in pans of water, thus insuring a constant saturation of the soil with moisture; in the second series they were only watered occasionally and enough to keep them from wilting too much; while in the third they were kept in normally moist soil. All were placed where they were exposed to a maximum amount of sunlight. Plants were selected from each series and caged with leafhoppers. Burning developed within twenty-four hours and increased daily on all those exposed to the insects, all these vines being badly injured at the time the experiment was closed. Excess of soil moisture did not retard the burning nor did lack of it increase the injury, there being no difference in the amount of tipburn on the leaves under these different soil moisture conditions. Check plants were perfectly healthy when the experiment was closed.

To test the influence of high humidity on the production of tipburn, one series of plants were kept under glass globes over the top of which panes of glass were placed to prevent evaporation and thus keep the air surrounding the foliage in a water-saturated condition. Another series were kept as a check and all were placed in sunlight. Individual plants from each were enclosed with leafhoppers. As in the case of the

other tests tipburn began within twenty-four hours after the insects had been colonized on the vines and increased in severity each day. At the time the experiment was closed it was noted that the burning on the vines kept under bell jar conditions was not as severe as in the other cases and was somewhat obscured by physiological injury due to abnormal conditions. The slight decrease of injury was due to the fact that many of the leafhoppers were drowned in the drops of water collecting on the sides of the glass globe and that others were killed by disease induced by the abnormally high humidity. However, enough survived to produce typical injury. Check plants showed no signs of tipburn. This test indicated that retarded leaf transpiration or air saturated with moisture will not check tipburn provided leafhoppers are present.

The last series of experiments were made to show the influence of sunlight on the production of tipburn, to test whether its absence would prevent or change the type of injury induced by the leafhopper or whether its presence would increase burning on plants as compared with those kept in the shade. One series were kept on a bench in the greenhouse under a glass painted a dark green, the pots being in this artificial shade at all times of the day. Another series were kept in direct sunlight. Individual plants in each series were enclosed with the leafhoppers. Tipburn began on all of these within twenty-four hours and increased daily. At the time the experiment was closed all vines exposed to leafhopper attack were dead or nearly so, while the others were perfectly normal. Tipburn developed just as readily and as severely on those kept in the shade as on those in sunlight, provided they were exposed to leafhopper attack, showing that sunlight is clearly not a direct factor in producing or influencing tipburn.

In December additional evidence was obtained showing that the leafhopper is the principal cause of tipburn and that environmental factors have little influence except as they affect the insect. At this time typical injury on potted potato plants in the greenhouse was produced by colonizing nymphs on the leaves. During this experiment the days were almost uniformly cloudy, there being very little sunshine. It was noticed in this experiment that the leaves did not brown as rapidly as they did in the field or during cage tests in the summer, but otherwise the injury was identical.

### Influence of Environmental Factors—Field Observations

Frequent observations were made in the experimental field to determine the progress of tipburn on the vines and daily counts[1] were made

[1]For a more detailed account see Albert Hartzell, "Further Notes on the Life History of the Potato Leafhopper" in Journal of Economic Entomology, Vol. XIV, 1921.

to ascertain the number of nymphs and adults present in the field. These results were plotted as shown in Figure 2. It is seen that there

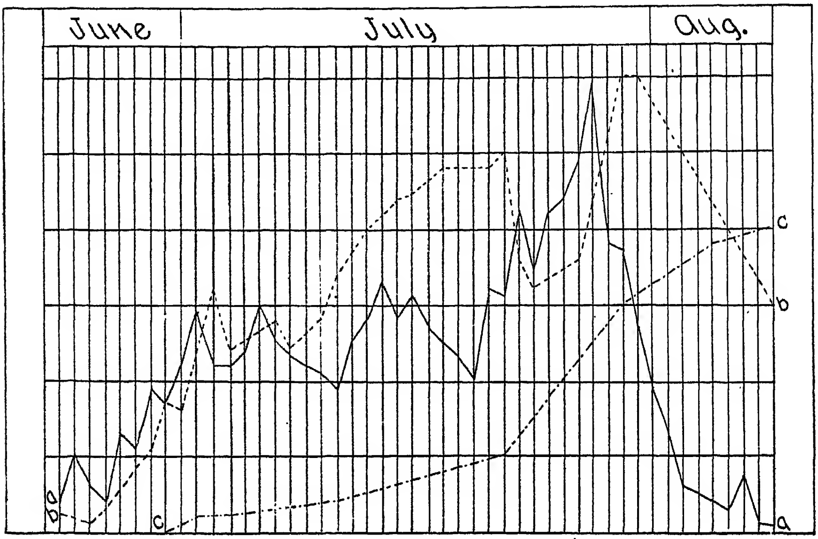


Fig. 2. Chart showing relation of leafhopper population to per cent. of tipburn. *a*, number of nymphs; *b*, number of adults; *c*, per cent. of tipburn.

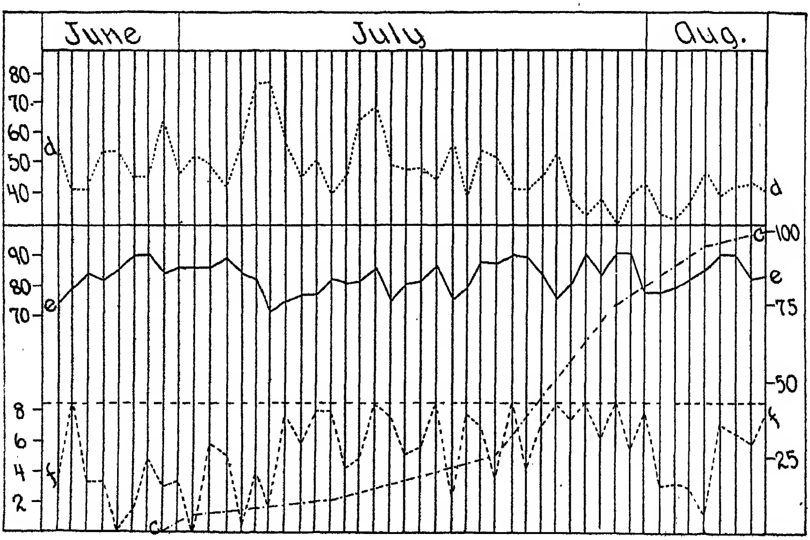


Fig. 3. Chart showing relation of climatic factors to per cent. of tipburn. *c*, per cent of tipburn; *d*, degrees minimum humidity; *e*, degrees maximum temperature; *f*, number hours sunshine.

was a distinct correlation between the leafhopper population and percentage of tipburn, the latter increasing with the increase in numbers of the leafhoppers. The abrupt drop in both nymph and adult curves was due to the death of all the plants in the field.

In Figure 3 curves were plotted representing the minimum humidity, maximum temperature, and total number of hours of sunlight, together with a curve showing the progress of tipburn in the field. The humidity records were taken from a hygrometer and checked with a sling psychrometer, and the temperature data were taken from readings from a maximum thermometer. The sunshine records were taken from a sunshine recorder and the total number of minutes of sunlight plotted from 9 a. m. to 4 p. m. It is seen that there was little correlation between the development of tipburn in this field and the amount of sunlight, maximum temperature, and minimum humidity.

## Is Tipburn Systemic?

It was repeatedly observed that tipburn could be produced on the leaves of a plant by the use of the leafhoppers and that the injury was always confined to the plant tissues on which the insects were feeding. In no case did the disease advance from one part of the plant to another without the agency of nymphs. The most striking of these experiments was one started September 17th. A healthy Early Ohio plant having four distinct branches was chosen. Twenty-four nymphs which had just hatched within the past twenty-four hours were placed on one branch having seven leaves besides a rapidly expanding bud. A wad of absorbent cotton was tied around the stem to prevent migration by the nymphs to other parts of the plant. Twenty-four hours later these leaves plainly showed first signs of injury. Only twenty-one nymphs were counted on this date, three having died or escaped. This number remained on the tip for the next four days with the leaves showing increased injury daily. On the fifth day but seventeen nymphs were counted, four having escaped. On this date half of the three oldest leaves were diseased, the two next oldest had the tip rolled in, while the others showed signs of injury in the paling of the chlorophyl about the tip and margins. On the eighth day but eleven nymphs were counted, the rest having escaped or died. On this date the two oldest leaves were dead, the apical half of the two next oldest were half burned, the two younger leaves showed marked symptoms, while the youngest leaf and the entire bud were of an unhealthy color and showed clearly a loss in succulence. On the ninth day the entire tip was badly burned. The nymphs were now in the fifth instar and many of them were noticed to be feeding on the petioles and stem. On the eleventh

day the entire tip showed increased injury, and was so badly burned by the twelfth day that the nymphs were removed, there being no food left. Six were still in the fifth instar, the remaining having matured. The plant was photographed a few days later. In addition to demonstrating the local nature of the disorder, the above experiment shows that in severe cases the leaf petiole, stem, and even opening leaves are affected, the nymphs feeding on these places when obliged to.

## Comparative Effect of Different Stages of the Insect

A set of experiments was conducted to determine the comparative effect of the different stages of the leafhopper on the potato foliage. In one test first instar nymphs were placed on normal leaflets and kept there by means of a wad of absorbent cotton tied around the leaf petiole. Leaves were confined with one, two and three nymphs, respectively. Those confined with one nymph developed the first symptoms in from six to nine days, depending upon the age of the nymphs which were in either the third or fourth instar. Those having two hoppers developed the first symptoms in from four to five days, the insects in this case being in either the second or third instar. Leaves on which three nymphs were placed showed tipburn in from three to five days, the insects being in either the first, second or third instar. When more insects were confined to a leaf, the burning developed still earlier. These tests showed that *mali* is capable of producing burning in all its nymphal stages, but that when one is confined to a leaf the amount of "toxic substance" introduced is not sufficient to produce the disease and that normally one nymph does not reach an "effective" size until the third or fourth instar.

In another series one and two fourth instar nymphs, respectively, were confined on potato leaves to determine the effect of this stage in developing tipburn. Five fourth instar nymphs placed on individual leaflets produced burning in from one to seven days. In all but one case the insect was in the fifth instar when burning was first noticed. Five leaflets on each of which two fourth instar nymphs were placed developed burning in from one to four days, there being little difference in the date of appearance of burning, whether there were one or two insects on the leaf. These and other experiments showed that where *mali* is in either the fourth or fifth instar, the symptoms are often produced on a normal leaflet within twenty-four hours.

In cages where equal numbers of adults and nymphs were added, burning developed much earlier and to a much greater extent in those cages having nymphs than in those having adults. Furthermore, adults confined to individual leaflets failed to produce the disease to any

extent whatever. Adults confined in cages on potato plants failed to produce any sign of burning if no nymphs were produced or if these were immediately removed after hatching. This indicates that, comparatively speaking, the adults are not nearly as effective in producing the disease as the nymphs are; that they will produce tipburn when introduced in great numbers on potato plants has been shown in field experiments.

## Effect on Potato Leaves Produced by Other Insects

To test the injurious effects of other insects on potato leaves, one series of plants were caged with Buffalo treehopper nymphs (*Ceresa bubalus*), tarnished plant bug adults (*Lygus pratensis*), aphids (species unknown), and flea beetles (*Epitrix cucumeris*). Each of these insects produced a typical form of injury that in no way resembled the tipburn caused by the leafhopper. Buffalo treehopper nymphs girdled the stems of the plants by causing the tissue at the points of puncture to collapse and the entire tip to bend over and wilt. Tarnished plant bugs collected at the tips of the plants and caused a wilting and death of this part. Aphids at first produced no injury, but when the colony increased in numbers the plant first yellowed and then died. Flea beetles at first ate the typical round holes in the leaves and then when more were added cleaned off the entire leaf epidermis, killing the plant.

## Why Does Bordeaux Mixture Prevent Tipburn?

It has been known for some time that Bordeaux mixture sprayed on potato plants reduced the amount of tipburn. When it was found that the leafhopper was responsible for the trouble attention was naturally attracted to the effect of this spray on these insects. Fluke[1] carried on some preliminary experiments which indicated that it had a repellent nature, and Parrott[2] substantiated these conclusions. It was observed, that under certain conditions Bordeaux mixture prevented tipburn to a large extent in our experimental plots, and as a result a series of cage experiments was started to discover the exact effect of this spray on the various stages of the leafhopper. The following results are preliminary but interesting.

August 30th a number of healthy Rural New Yorker variety potato plants growing in large two gallon crocks were sprayed with lime water and different strengths of Bordeaux mixture, each formula being used

[1]Fluke, C. L. Journal of Economic Entomology, Vol. 12, 1919, pages 256–257.

[2]Parrott, P. J. and Olmstead, R. D. Journal of Ecomonic Entomology, Vol. 13, 1920, pages 224–225, and New York Geneva Tech. Bull. 77, 1920.

alone and with nicotine at the rate of one part of this to 800 of Bordeaux mixture. Each plant was sprayed thoroughly with a small atomizer spray pump, both the upper and lower surfaces of the leaves being given a thorough coating. Plants were selected having two or more branches, one branch being protected from the spray at the time of application by being enclosed in a glass cylinder. After the spray material had thoroughly dried an equal number of fertile females were introduced into each cage. After ten days the females were removed and the hatching nymphs counted daily. It had been previously demonstrated that the very young nymph remained near the point of emergence from the leaf tissue for at least twenty-four hours after hatching. By counting the number of nymphs found on sprayed and unsprayed leaves it could be determined whether or not the egg had been laid in tissue coated with Bordeaux. The following table summarizes the results.

TABLE I.—COMPARISON OF HATCHING OF *E. mali* ON SPRAYED AND UNSPRAYED LEAVES

| Cage No. | Lime formula | Bordeaux formula | No. female hoppers introduced | No. removed | No. nymphs hatched on unsprayed leaves | No. hatched on sprayed leaves | Total |
|---|---|---|---|---|---|---|---|
| a | 4-50 | | 5 | 4 | 60 | 0 | 60 |
| b | 4-50[1] | | 5 | 4 | 50 | 1 | 51 |
| c | | 4-4-50 | 5 | 2 | 31 | 4 | 35 |
| d | | 4-4-50[1] | 5 | 2 | 16 | 2 | 18 |
| e | | 5-5-50 | 5 | 2 | 23 | 2 | 25 |
| f | | 5-5-50[1] | 5 | 1 | 12 | 0 | 12 |
| g | | 4-6-50 | 5 | 3 | 25 | 2 | 27 |
| h | | 4-6-50[1] | 5 | 2 | 3 | 0 | 3 |
| | Total | | | | 220 | 11 | 231 |

[1]Nicotine added.

From the above preliminary test it was found that out of a total of 231 fertile eggs laid by the females but 11 were deposited in sprayed leaves. It was also noticed that in every case of a nymph hatching on a sprayed leaf, the latter was always imperfectly covered by the insecticide. While there are not enough data to indicate the comparative effect of different Bordeaux formulae on the adults, it is evident that this mixture or even lime water will repel the adults under certain conditions. Thus oviposition is prevented, provided the leaves are thoroughly covered by the spray, and there are unsprayed plants on which they can oviposit.

## Conclusions

1. Tipburn or hopperburn of the potato is produced through the agency of *Empoasca mali*.

2. All nymphal stages of the leafhopper are capable of producing symptoms of the disease.

3. The older the nymphs the greater the amount of injury done, nymphs in the first and second instars being incapable of producing any effect on the leaf unless in numbers.

4. The greater the number of nymphs on a leaf the sooner the injury develops and the more rapidly the leaf or plant is killed.

5. The adult hopper is not nearly so effective as any of the nymphal stages but will produce the disease when concentrated in large numbers on a given plant.

6. The disease is produced to the same extent and just as soon under such diverse environmental conditions as type of soil, amount of moisture in the soil, presence or absence of sunlight, or reduced leaf transpiration.

7. Tipburn as a disease is localized, being confined to that part of the plant exposed to the attack of the leafhoppers, whether this be a leaflet or entire branch.

8. Other insects known to feed on potato such as Buffalo treehopper nymphs, tarnished plant bugs, potato aphis, and flea beetles, produce a type of injury characteristic of the individual species concerned but in no way resembling tipburn.

9. Bordeaux mixture prevents tipburn by repelling the ovipositing female leafhoppers.

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President Wilmon Newell: This subject is now open for discussion.

Mr. R. L. Webster: I would like to ask if any allowance was made for unavailable soil moisture; that is, sand as compared with loam?

Mr. F. A. Fenton: We kept certain potted plants in a pan of water all the time, and we also kept them where the sand or loam was dry. There is a difference in the plant growth but not in percentage of tipburn.

Mr. R. L. Webster: There would be considerable difference in loam.

Mr. F. A. Fenton: We found that we got tipburn just as quickly on plants in good rich soil as in sand. I noticed in traveling about the state that the type of soil seemed to make little difference. For instance, one field had but one spot that was badly tipburned and that was in a low part where there had been much water. Tipburn is always correlated with the number of leafhoppers. We found out, too, that the disease, you might call it such, is not systemic, that is, it does not travel from one part of the plant to another without the agency of the leafhopper.

Mr. R. L. Webster: I made some chemical tests recently on the effect of red spiders on the foliage of roses. There seems to be an accumulation of mucilages and pentosans; substances that take up water. That may be a factor in this situation.

Mr. J. E. Dudley, Jr.: An experiment at Madison, Wisconsin, this year might be of interest in connection with the previous papers. Individual plants of five varieties of potatoes were caged, two cages to each variety. In one cage over each variety there were about twenty adult leafhoppers placed the 12th of July. The other cages remained free of leafhoppers the whole season. In every case hopper-burn occurred in the cages in which leafhoppers were placed and in no case did it occur in cages which were kept free from them. In the cages in which it occurred it was not nearly as serious per variety as in the rest of the field, which would look as though the partially decreased transpiration in the cages retarded the spread of hopper-burn.

Potato flea beetles and potato aphids were found in all the cages. It was impossible to keep them out. As no hopper-burn occurred in the check cages, it would look as though we could eliminate these two insects as causal agents.

My experiments differ slightly in one respect from Mr. Fenton's; that is the rate of spread of hopper-burn. Observations would appear to indicate that hopper-burn will spread over a whole plant once the plant has been affected. I have seen that in several cases where one or two hoppers were placed on a plant for a week, say, and then taken off and the plant continued to droop until it was entirely dead.

Mr. F. A. Fenton: We tried that experiment time and time again and we absolutely did not get any tip-burn. We caged a plant with adult leafhoppers and we knew that this plant was loaded with eggs. The hatching young were transferred from the leaves every twenty-four hours and no tip-burn was noticed. We had counts as high as several hundred young from one plant and yet when we removed these every day we did not get any tipburn.

Mr. T. J. Headlee: I would like to know from Mr. Eyer whether there was any late blight connected with the experiments that would in any way influence the yield.

I would like to know from the last speaker whether tip-burn in his opinion is ever caused by any other agency than the hopper. I would like to know from Mr. Fenton what he considers the diagnostic characters of hopper-burn.

Mr. J. R. Eyer: In answer to Dr. Headlee's question regarding the matter of late blight, according to our plant pathologist who is located

at the experiment station, this disease was not a factor in any of our experiments for either 1919 or 1920, because we had no late blight in these potato plots.

Mr. F. A. Fenton: In regard to the diagnostic characters, our results were identical with those of Dr. Ball,—that is, that the injury invariably begins at the tip or margin of the leaf and follows the veins. The vein will collapse first and then the tissues between will die. In other forms of tip-burn, the tissue between the veins will die and the veins themselves will remain green. If you put a large number of leafhoppers on the plant the leaves will wilt before they turn brown.

That reminds me that recently in the Potato Magazine, a gentleman from Vermont said that he produced tip-burn by concentration of sunlight on the plant through mirrors. It strikes me that this is abnormal. You would not find that in field conditions. On the other hand, you would find leafhoppers in the field.

Mr. E. D. Ball: Further answering Mr. Headlee, there are four things that we find on the potatoes very commonly, and when you mention the diagnostic character of tip-burn you only need then to differentiate it from the other three. Under certain conditions, especially in greenhouses, you will often get a burning—a sunburn of potatoes —a case where the leaves have been subjected to too high termperature and too small moisture content in the soil and they actually die. In those cases you almost invariably find that the leaf is light in color. There is no relation to the veins and there may be no relation to the margin. You may have the burning right across the leaf, in the center, or any place like that. That, of course, is a rare thing. Besides that you have the two blights. But tip-burn is brown in color, always occurs on the margin of the leaf and runs in on the veins. The blights are almost invariably membrane troubles and not vein troubles, and cross right across veins angularly or in any way; it may occur inside of the leaf and not have any reference to the margin. Tip-burn is a margin and a vein condition and it occurs on the margin and runs in a V on the veins.

Mr. Z. P. Metcalf: I think we have here a complication of physiological processes which are really very poorly understood. It must be remembered that this same potato leaf-hopper is in the South the principal insect enemy of the soy-bean and causes on the leaves of the soy-bean a peculiar leaf spot on which a plant pathologist that I know worked for about five or six years and never arrived anywhere. He separated a distincitve organism from this spot, and yet he never could get that organism transferred from one leaf to another, unless the leaf-hopper was there.

Here we have the same insect, as far as anybody knows, producing an entirely different effect on another plant. And in this connection I want to say that we are studying the physiology of leaf spots on various plants caused by leaf-hoppers and plant-hoppers, and we find a great many of the spots that have been described in pathological literature are intimately bound up with these peculiar kinds of insects, but we know very little about the real physiology behind these things as yet.

MR. T. J. HEADLEE: One year ago this summer I asked Professor Ball about the diagnostic characters of this kind of injury. He gave them to me very much as they were stated to-day. I used the information to examine the conditions in our state. We raise about 15,000,000 bushels of potatoes, and I found some leaf-hopper injury, but I did not fine leaf-hopper injury or leaf-hopper burn as the principal source of what the plant pathologists usually call tip-burn.

MR. J. G. SANDERS: I had the privilege, last summer, of observing in Holland some very extensive experiments along this very line. Potatoes of similar varieties were similarly caged in cages of similar sizes made up of glass, wire and cloth. Invariably those potatoes with hoppers had tip-burn.

MR. P. J. PARROTT: It may be of interest to Dr. Headlee to hear of an experience with tip-burn in New York. In 1908 the leafhopper was very abundant on potatoes, and much browning of the foliage was noted in plantings where the insects were numerous. Injuries to the foliage were diagnosed by a phytopathologist as typical tip-burn, which identification by the way, mislead us as to the destructive capacities of the insects. In planning for field experiments with the leafhopper in 1919 we secured the assistance of a phytopathologist, who noted the occurrence of various diseases in the different plats. As some of you know, the unsprayed rows or checks were practically destroyed. The browning of the foliage was almost entirely due to the work of the leafhopper and Mr. Stewart, our phytopathologist, has gone on record as saying that the diseased condition of the check plants was not distinguishable from what he has heretofore designated as tip-burn.

MR. H. A. GOSSARD: I want to make one or two observations as to the cost of preventing tip-burn. It would appear to me that the cost of preventing tip-burn might exceed the value that you get in increased yield, yet because of the fact that leafhoppers are also concerned in transmitting fungus and bacterial disease, I would regard the appearance of tip-burn in a potato-patch as a good hint to get busy, regardless of the fact that it might cost more to prevent tip-burn than to suffer from it, because I might be preventing something much more costly than tip-burn.

PRESIDENT WILMON NEWELL: The next paper on the program is entitled "Chinch-bug Resistance Shown by Certain Varieties of Corn," by W. P. Flint.

## CHINCH-BUG RESISTANCE SHOWN BY CERTAIN VARIETIES OF CORN

By W. P. FLINT, *Urbana, Ill.*

In localities where chinch-bugs have been abundant for a number of years, one will frequently hear statements from farmers that certain varieties of corn are not greatly damaged by them. Investigations of these statements have shown in most cases that some other factor than varietal resistance has been responsible for lessening the chinch-bug injury.

In the summer of 1917, Mr. J. J. Doerschuk, then county agent in Randolph county, Illinois, called the writer's attention to the fact that a variety of corn known locally as White Democrat seemed to be showing marked resistance to chinch-bug attack.

In the spring of 1918, under the supervision of Mr. Doerschuk, seven varieties of corn were planted in four-row strips in a field in a locality where chinch-bugs were extremely abundant. These varieties included White Democrat, Iowa Silver Mine, Boone County White, Sutton's Favorite, St. Charles County White, Yellow Ninety Day, and Reid's Yellow Dent. There were but few chinch-bugs in this field up to the time of their summer flight, which occurred when the corn was about three feet high. A general heavy infestation of the field resulted. The second brood of bugs was very abundant in this field. Early in October the stalks and ears from ten hills of corn of the White Democrat, Iowa Silver Mine, and Reid's Yellow Dent were carefully weighed, the weights being 53, 17, and 11 pounds, respectively. None of the other varieties were as good as the Reid's Yellow Dent.

In 1919, White Democrat and a local strain of Reid's Yellow Dent were sown in alternate strips of two rows each in fields of fifteen to twenty acres in two widely separated localities where chinch-bugs were abundant. By the first of September one could easily distinguish the varieties from a distance, at least 80 per cent. of the White Democrat stalks were standing, while the stalks of Reid's Yellow Dent had nearly all fallen from the effect of the chinch-bug injury. The corn was harvested in October, in one of the fields Reid's Yellow Dent yielding 21½ bushels and White Democrat 30½ bushels per acre; in the other 15½ and 19½ bushels per acre, respectively. The difference in the corn was very marked, the White Democrat being well matured and in good condi-

tion for cribbing. The Reid's Yellow Dent, on the other hand, was soft and spongy, and practically worthless.

In 1920 further experiments were conducted. Varieties were selected because of their known resistance to drouth and supposed adaptability to the type of soil found in the counties most heavily infested with chinch-bugs. The varieties used were White Democrat, Black Hawk, St. Charles County White, Arlington Prolific, Pride of Saline, U. S. Selection 77, Freed W. Dent, Colby Bloody Butcher, Lancaster Surecrop, U. S. Selection 133, Minnesota No. 13, Northwestern Dent, and Gehu. These varieties of corn were secured through the Crops Department of the United States Department of Agriculture, from entomologists in adjoining states, and from the Crops Department of the University of Illinois.

During the summer flight of the chinch-bugs, all varieties in the field were heavily infested. There was a more noticeable difference in the effect on the several varieties in this season's test than in any of those previously conducted. By September 6th, every hill of two varieties had been killed, all the others showing more or less injury from the bugs. The White Democrat, Black Hawk, and St. Charles County White were in a fair condition, considering the severity of the infestation. The corn was harvested October 2d and carefully weighed by Mr. S. C. Chandler of this office. The results show a variation in yield from nothing in the case of Gehu and Northwestern Dent, to 16.5 bushels per acre in the case of the White Democrat. Two fields of about twenty acres each in another locality where chinch-bugs were very abundant were planted half to Reid's Yellow Dent and half to White Democrat. The corn in these fields was harvested late in October, the White Democrat making from twenty to twenty-five bushels per acre, while the Reid's Yellow Dent was so badly damaged that practically none of the ears had matured. No yields were taken.

Field observations in the counties heavily infested with chinch-bugs have shown the White Democrat corn markedly resistant when grown on fertile soil. No fewer bugs have been found on this corn than on other varieties. The higher yield of this and several other varieties seems to be entirely due to their power to resist chinch-bug attack. All are corns of the flint type. The White Democrat, which is a strain of Champion White Pearl, has a thick, leafy stalk, and a blunt, rather short, ear. The kernel is broad, smooth, and hard, with a high protein content. Black Hawk, the next highest yielding variety in the 1920 tests, is a similar red corn.

More extensive tests including a number of other varieties will be conducted during next season. It is not thought possible to develop

any strain of corn sufficiently resistant to chinch-bug attack to withstand the onslaught of the nearly full-grown first brood bugs when they leave the wheat fields at harvest time. The results thus far obtained seem to prove that certain strains of corn show greater resistance to chinch-bugs than others, and that where these strains are grown on fertile soil in areas infested by chinch-bugs and protected from attack by the first brood of bugs, moderate yields may be expected.

President Wilmon Newell: How did these varieties compare in maturity at the time of the chinch-bug attack?

Mr. W. P. Flint: There was some difference in the different varieties, but it was not very great. We tried to select those with similar maturity. They were all varieties that mature in about 100 to 110 days.

President Wilmon Newell: The next paper is by Mr. E. P. Felt, on the "European Corn Borer in New York State."

## EUROPEAN CORN BORER IN NEW YORK STATE

By E. P. Felt, *Albany, N. Y.*

The known infested area in New York State as indicated by published Federal quarantines, comprises 67 towns and cities located in 11 counties, a total area of over 2200 square miles.

The eastern infested area includes 1326.76 square miles according to data kindly supplied by Mr. Worthley, is irregularly rectangular in shape and centers approximately upon Schenectady. The federal scouting of the present year has added 12 towns to this area, the extension rarely exceeding five miles in any one direction and since an area of about two towns has been scouted outside the infested territory, the limits of this infestation are fairly well defined and the spread must be characterized as moderate, certainly not alarming.

The western area covers 936 square miles, the extensions this year north of Buffalo and west of Dunkirk being approximately 25 miles in each direction and including 14 additional towns. It was not possible to scout this area as thoroughly as was desirable in 1919 and consequently a portion of this new area may have been due to infestations not disclosed the preceding season.

The following data are based upon field work conducted by Mr. D. B. Young and Hall B. Carpenter under the writer's direction, the eastern area being given the closest attention.

Planting of sweet corn in the eastern area began as early as May 14th and some of the very early fields were up the 23d, some fields of field

corn being 10 to 13 inches high July 7th and some early sweet corn mostly tasseled out by the 26th.

Corn develops so early and the moths fly so late that oviposition upon the ear with little leaf or tassel injury may occur and this seems to have been the case in at least one field.

The first pupa was reported by federal men June 15th, the first moths were taken in the field July 1st and the first egg masses July 8th while the last moth was found in the field July 29th. There was no evidence of the development of a second brood or the deposition of eggs and the development to full grown caterpillars of corn borers upon plants other than corn, although larvae were active as late as November 12 when freezing temperatures prevailed at night and snow squalls occurred in the day.

### Stubble Infestation

An area of a field having a 10.52 per cent stalk infestation was carefully examined and the 551 stalks contained 68 borers or a stalk infestation for this area of 12.34 per cent. The stubble was also examined, each butt being cut open and only four borers were found or an infestation of but .72 per cent.

Another field with an average stalk infestation of 34.85 per cent. was also examined and in this case the stubble was cut unusually high, approximately 15 inches and out of 310, 42 or 13.54 per cent. were infested.

In both fields, the number of borers at or below the surface of the ground was very small, probably less than 0.10 per cent.

The observations in the eastern area were checked by examinations in the western section and so far as could be determined, development was practically identical though in the western area there appeared to be a somewhat heavier infestation about Silver Creek and in certain fields a relatively greater invasion of nearby plants by partly or nearly full grown borers.

The stalk infestation in the Schenectady area varied from nearly 35 per cent. on some river bottom fields near the presumable center of the infestation to a very sparse occurrence of the borers on the outer margins of the infested territory.

Corn fields showing a stalk infestation of 10 per cent. or more were limited to an irregular, narrowly triangular area centering approximately upon the river flats of Scotia and covering some 15 square miles, the greatest extension from the presumable center being five miles up the Mohawk river and about three miles back from the river.

The area comprising fields which may show a stalk infestation of from 5 to 10 per cent. covers approximately 25 square miles lying out-

side of the more heavily infested section mentioned above, and extends up the river for about eight miles and back from the river some five miles.

The above statements regarding infestation should not be construed as implying that all fields in either area are necessarily infested to the degree indicated because as will be pointed out below, much appears to depend upon the time of planting, the nearness of infested materials and the direction of the prevailing winds.

The influence of the time of planting in the infested area is strikingly shown by two fields of Howling Mob sweet corn, one planted May 20th and next an infested field of last year and the other planted July 7th and only 100 feet away across a road. The first had a stalk infestation of 10.52 per cent and in the second only one affected stalk was found. In another instance over three acres were planted with Early Dawn and Golden Bantam May 8th and 13th and had a stalk infestation of four per cent. while a nearby acre of Golden Bantam planted June 25th had but three stalks affected or less than one per cent.

The date of planting is only an approximate indication of the condition of growth at the time the moths fly. A rather striking instance of this was found in western New York in a large field which was planted on the same date, approximately one-half being in White Dent and the other half in Evergreen. The latter was nearer the presumable source of infestation and yet showed a hill infestation of but 7.5 per cent. as compared with the White Dent of 18.18 per cent. The owner stated that the Evergreen developed more slowly and the probabilities are that the White Dent was in a more attractive condition at the time the moths were flying and consequently they passed over the Evergreen in great measure and oviposited mostly in the White Dent. It is worthy of note, in this connection, that depressions in rolling fields, if conditions permit early and vigorous growth, are likely to show a heavier infestation.

The nearness of infested material has a decided influence upon infestation. The heaviest infested fields were near known sources of infestation and in a number of cases the infestation began and was decidedly more marked on the side of the field next an earlier infested area or source of infestation.

The direction of the prevailing winds likewise has an important influence. One of the most striking cases was that of two fields in the Mohawk river bottom, one with a stalk infestation of 19.94 per cent. and the other of only 5.46 per cent. The first was in direct line of the prevailing winds from an infested area of the preceding season and the other only about 200 feet north and therefore outside the presumably usual drift of the moths.

It is difficult to make general statements applicable to the infested area with its numerous variations in the amount of injury due to local causes. Generally speaking a 30 per cent. stalk infestation is necessary to produce marked, commercial injury though in some fields with a 10 per cent. stalk infestation as high as five per cent. of the ears of sweet corn were affected and judging from conditions in other single brooded areas, a 90 per cent. stalk infestation of field corn by no means implies the destruction of the entire crop, though it does involve serious damage. There has been in New York State no very serious losses due to the actual work of the European Corn Borer though the 30 per cent. to 40 per cent. stalk infestation in the more seriously infested areas suggests a probability of increased injury and possibly an approximation to the great damage caused in certain Canadian areas.

The developments of the past season in New York State indicate a continued though not excessive spread accompanied apparently by increasing injury which may reach serious proportions, unless the true character of the insect is recognized and agricultural practices modified so as to reduce to a practical minimum the probabilities of the insect wintering successfully. With these conditions in mind, the State is giving special attention to the promotion of better methods of handling the corn crop in order to anticipate possible serious damage and at the same time is cooperating with the Federal Government in enforcing quarantine regulations designed to control the spread of the pest, especially through commercial agencies.

Mr. Glenn W. Herrick: I noticed in Dr. Howard's last report that the moth had been found depositing its eggs on several different food plants other than corn.

Mr. W. R. Walton: Eggs have been found in considerable number on beet stems and celery during the latter part of the season, and on two or three other cultivated plants. These data will all be published soon.

Mr. F. A. Fenton: I would like to ask if eggs laid on these food plants necessarily mean that the larvae will develop. This year we had a very bad outbreak of the army worm in Iowa. The Tachina fly reduced them to a minimum, and later when these flies came out in tremendous numbers, they had to lay their eggs on something, and practically every insect that was abundant was oviposited on. We found Colorado potato beetles covered with eggs, probably of this species, but they did not develop.

Mr. W. R. Walton: This is the first season that corn borer eggs have been found on these particular plants. They have been known

to be infested by the larvae for several seasons, and the insect has been reared to maturity from them.

MR. C. H. TURNER: In regard to the size of the plant, we had results at the Schenectady laboratory that bore out Dr. Felt's conclusions. We had one plot planted the eighth of May and another the last of June. The infestation was almost entirely in the older plot. The moths had crossed the young corn to reach the earlier plot, and they showed selection according to the height of the plant. Most of the eggs were laid on the taller corn, particularly on the large, broad-leaf varieties.

MR. E. P. FELT: I would like to ask if there are any data to show a tendency toward infestation of one variety or a group of varieties, rather than another.

MR. C. H. TURNER: Yes. The large, broad-leaf varieties showed evidence of infestation. This was particularly true the first of the season. Later, the smaller varieties, while they did not have as many eggs, in the early part of the season, acquired infestation probably from migration.

At the end of the season, the stalk infestation was slightly greater in the smaller varieties. The average for the small varieties was about 42 per cent.; in the larger ones, 38 per cent. These figures are approximately correct.

PRESIDENT WILMON NEWELL: The next paper is "The Corn Leaf Aphis (*Aphis maidis Fitch*) in Kansas," by J. W. McColloch.

## THE CORN LEAF APHIS (*Aphis maidis* Fitch) IN KANSAS[1]

By J. W. McColloch, *Associate Entomologist, Kansas Agricultural Experiment Station*

The data on which the present paper is based are the results of certain observations made while studying corn insects at this Station. The study was prompted by numerous complaints of injury reported during the past few years, and by an apparent minimizing of the damage done by this insect. The results indicate that in Kansas, *A. maidis* must be considered not only as a serious pest of corn, but also as an enemy of the various sorghum crops. It is present every year on these crops, causing more or less injury, but as in the case of many of the aphids, it is difficult

[1]Contribution No. 62 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project 9 of the Agricultural Experiment Station.

to estimate the actual loss since much of the injury is obscure and often attributed to other factors. During the past five years, several distinct lines of investigational work have been under way. The present paper, however, is limited to a discussion of the more important types of injury and to certain experiments indicating possible means for the reduction of the injury.

## Injury to Corn

In the case of corn, all parts of the plant above ground are subject to injury, although the greatest damage occurs to the tassel. The aphids usually appear on corn during the last of June or the first of July, and are to be found deep in the curl feeding on the tenderer parts of the leaves. As the tassel develops in the curl, these insects forsake the leaves, concentrating on the tassel and especially on the central branch, resulting in several types of injury. The entire tassel may become so heavily infested that it fails to function (Plate 2, fig. 1). This type of injury was rather common in 1919, amounting to 10 per cent. of the plants in many of the fields about Manhattan. A more common form of damage, however, is caused by the concentration of the aphids in the central branch and a few adjacent branches of the tassel where they prevent the shedding of pollen by sapping the juices and gumming the spikelets with honey dew (Plate 2, fig. 3a). In 1920, in the vicinity of Manhattan, approximately 50 percent. of the corn plants exhibited this type of injury to such an extent that no pollen was shed. This meant a loss of from 15 to 20 percent. of the pollen, and since the central branch is the first to shed pollen, this is an important item. The corn crop of Kansas is often dependent on the early pollination of the silks, since the hot winds and dry weather of midsummer may be fatal to both tassels and silks. In addition, the emergence of the tassel may be delayed or it may not fully emerge from the boot, in either case resulting in a loss of pollen. Plate 2, figure 2, shows a plant whose tassel has not fully emerged from the boot, while plate 3, figure 4 shows a normal tassel. In the case where the tassel does not fully emerge, much of the pollen is caught in the axils of the leaves where it offers an ideal medium for the development of molds and rots, frequently resulting in the entire loss of the top. These growths often extend down the stalks (Plate 3, fig. 5), producing a weakened condition which is detrimental to the developing ear. As a rule the leaves show little injury, but in cases of severe infestation they may become yellow and occasionally die. During the past two years very little direct injury to the ears has been noted. In a few cases aphids were found in large numbers on ears when they were feeding on the silks and the soft grains. As a result, maturity was hastened and the ears were small and poorly filled.

Indirectly, this aphis may also be considered injurious to corn, since the honey dew secreted by it forms one of the main sources of food for the moths of the corn earworm and other insects of the corn field. It is also generally associated with physodermal disease of corn and there is a strong possibility that it may be concerned in the transmission of this disease.

### Injury to Sorghums

The injury to sorghums, while general throughout the state, appears to increase westward. Mr. J. H. Parker of the local Agronomy Department, after a trip through western Kansas in September, 1919, examining sorghum fields, reported that the corn leaf-aphis had ruined the crop in that section. The heads were very heavily infested and the grain so badly shriveled that much of it was worthless.

All kinds of sorghums are attacked by the aphids, although there is apparently a difference in the injury of the different varieties. The percentage of plants showing appreciable injury in a test of seventeen varieties conducted in 1919 by Mr. W. P. Hayes, varied from 3.1 percent. in the case of Sudan grass to 96.5 percent. for feterita (Table I).

Table I.—Percentage of Plants Showing Appreciable Injury in Variety Test of Sorghums, 1919

| Variety | Percent. plants injured | Variety | Percent. plants injured |
|---|---|---|---|
| Black hull kafir | 77.8 | Feterita | 96.5 |
| Dwarf black hull kafir | 65.0 | Freed's Sorghum | 78.8 |
| Dawn kafir | 46.2 | Red Amber | 85.8 |
| Shrock kafir | 91.6 | Kansas Orange | 25.8 |
| Sunrise kafir | 67.1 | Sumac Sorghum | 46.4 |
| Pink kafir | 74.9 | Dwarf Sumac Sorg. | 21.3 |
| Red kafir | 84.5 | Hagena | 67.1 |
| Dorso | 96.3 | Sudan | 3.1 |
| Yellow milo | 77.6 | | |

As in the case of corn, several distinct types of injury are noted. The infestation usually begins in the developing curl, and the aphids feed on the more succulent part of the leaves. As the heads develop they attack these, sapping the juices from the developing grain. The heads often become covered with the honey dew and later with molds or fungi, which give them an unsightly appearance. The reddish discoloration on the sorghums, due to bacterial infections, is usually associated with *A. maidis*, and often becomes serious enough to cause the rotting of the whole stalk. In 1920 the stalks of from 7 to 10 percent. of the plants in a kafir field were heavily infested with *A. maidis* and bacterial blight. The infestation resulted in shrinking the head, causing a loss of about 33 percent. in weight and 50 percent. in volume. (Plate 3, fig. 6).

### Control

*A. maidis*, like many of the aphids, presents numerous difficulties in the way of control. The great rapidity with which it increases, its

manner of feeding, at least in part, in protected situations, together with the fact that the seasonal history is only indefinitely known, indicate some of the difficulties to be encountered. Experimental tests with nicotine sulphate sprays gave excellent results in killing the aphids, but the problem of spraying corn and sorghum fields is out of the question.

Certain observations on the date of planting corn and on variety tests of corn indicate that the injury can be materially reduced, and that further studies along this line may open the way for definite methods of control.

## Time of Planting Corn

Observations were made in 1919 and 1920 on the number of plants injured in the Time of Planting Corn experiments conducted by the Entomology Department, and also on a date of planting test at the Agronomy farm in 1919. The counts of 1919 include only those plants showing severe injury such as is seen in Plate 2, figure 1, while the 1920 counts took into consideration all plants showing appreciable injury. The results, which are presented in Tables II to IV, indicate that with the possible exception of Hildreth, the injury increases with the delay in planting until about the middle of May.

Table II.—Percentage of Plants Showing Severe Injury, Entomology Plots, 1919

| Variety of corn | Date of Planting April 15 | May 1 | May 15 | June 1 | June 15 |
|---|---|---|---|---|---|
| Boone Co. White | 13.9 | 10.6 | 18.3 | 18.3 | 13.8 |
| Pride of Saline | 7.6 | 11.8 | 17.0 | 19.9 | 13.7 |
| Commercial White | 18.6 | 21.3 | 25.2 | 27.7 | 20.2 |
| Kansas Sunflower | 7.6 | 10.8 | 14.4 | 16.6 | 15.6 |
| Hildreth | 17.8 | 12.6 | 12.6 | 16.0 | 12.5 |

Table III.—Percentage of Pride of Saline Plants Showing Severe Injury, Agronomy Farm, 1919

| Method of Planting | Date of Planting April 16 | April 21 | May 3 | May 10 | May 20 |
|---|---|---|---|---|---|
| Open furrow | 4.8 | 8.6 | 10.0 | 15.7 | 10.0 |
| Listed | 8.9 | 9.5 | 18.0 | 16.9 | 10.1 |
| Surface planted | 5.6 | 5.0 | 10.7 | 9.8 | 4.7 |

Table IV.—Percentage of Plants Showing Appreciable Injury, Entomology Plots, 1920

| Variety of corn | Date of Planting April 24 | May 1 | May 8 | May 15 | May 22 | May 29 |
|---|---|---|---|---|---|---|
| Boone Co. White | 58.9 | 58.1 | 67.8 | 63.7 | 64.5 | 67.1 |
| Pride of Saline | 58.1 | 45.0 | 49.2 | 58.3 | 66.6 | 56.9 |
| Commercial White | 59.6 | 65.7 | 58.1 | 67.7 | 65.3 | 41.4 |
| Kansas Sunflower | 48.2 | 46.7 | 55.1 | 56.5 | 59.1 | 55.1 |
| Hildreth | 50.0 | 47.7 | 46.5 | 50.0 | 57.3 | 44.0 |

## Variety Tests of Corn

The observations on different varieties of corn were similar to those on the Date of Planting Tests in that only severe injury was counted in 1919, while all plants showing appreciable injury were noted in 1920.

Referring to Tables II and IV, it will be noticed that Commercial white shows a marked increase in injury over the other varieties in nearly all the date plots. Likewise, there is some indication that Hildreth is not as susceptible to injury. In order to determine whether Commercial White was as badly injured when grown in general fields, a comparison was made between a field of it and a field of Pride of Saline, both fields being planted about May 5. The field of Commercial White had 14.9 percent. of the plants severely injured, while Pride of Saline had only 6.8 percent. In addition to these experiments, counts were made of the injury in variety tests in the Entomology plots and at the Agronomy farm. The result of these studies are presented in Table V.

TABLE V.—PERCENTAGE OF PLANTS SHOWING SEVERE INJURY IN 1919 AND APPRECIABLE INJURY IN 1920[1]

| Variety | Agrcnomy Farm First Series 1919 | Agromony Farm Seccnd Series 1919 | Entomology Plots 1919 | Entomolcgy Plots 1920 |
|---|---|---|---|---|
| White Democrat | | | 32.0 | 56.7 |
| Commercial White | 14.1 | 18.3 | 21.3 | 59.9 |
| Midland Yellcw Dent | 17.4 | 13.3 | 23.4 | 46.2 |
| Freed's x Pride of Saline | 8.9 | 13.4 | | |
| Corn Planter | 9.4 | 11.5 | 24.2 | 51.3 |
| Pride of Saline | 10.3 | 12.3 | 11.8 | 53.8 |
| Roseland White | 11.7 | 9.5 | | |
| 20th Century | 4.2 | 2.3 | | |
| Hildreth | 9.7 | 8.0 | 12.6 | 56.4 |
| Shawnee White | 6.6 | 8.1 | 22.4 | 50.5 |
| Boone County White | 5.5 | 9.6 | 10.6 | 59.3 |
| Reid's x Pride of Saline | 4.1 | 13.2 | | |
| Reid's Yellow Dent | 4.1 | 11.0 | 17.7 | 47.4 |
| Iowa Silvermine | 17.8 | 6.8 | 13.0 | 44.8 |
| Kansas Sunflower | 3.3 | 10.1 | 10.8 | 49.2 |
| Colby Bloody Butcher | 2.9 | 5.6 | 10.0 | 37.2 |
| Sherrod x Pride of Saline | 4.2 | 1.7 | | |
| Freed's W. D. | 1.0 | 3.3 | 9.1 | 43.3 |
| Corn Planter x Pride of Saline | 2.6 | 6.3 | | |
| Funk Yellow Dent 330 | | | 7.5 | 29.7 |
| Funk Yellow Dent..329 | | | 6.2 | 29.5 |
| Sherrod W. D. | 2.7 | 0.0 | 3.8 | 39.6 |
| Funk Y. D. 335 | | | 2.8 | 37.0 |
| Funk Bloody Butcher | 0.0 | 0.0 | 3.7 | 34.5 |
| Ninety Day | 2.3 | 0.5 | | |
| Crille Bloody Butcher | | | 5.0 | 18.5 |
| Deyo N. W. Dent | | | 2.3 | 20.1 |
| Silver King | 0.0 | 0.6 | 2.2 | 19.8 |
| Minnesota No. 13 | 0.0 | 0.0 | 1.9 | 5.7 |
| Deyo Bloody Butcher | | | 0.6 | 11.6 |

[1]The varieties are ranked in this table with relation to their apparent susceptibility to injury.

In summarizing the data presented in Table V, it will be noted that the amount of injury increases with the lateness of the variety. Late maturing varieties, such as White Democrat, Commercial White, Midland Yellow Dent, and Corn Planter, suffered the greatest damage, while such early maturing varieties as Minnesota No. 13, 90 Day, Funk Yellow Dents, and the various strains of Bloody Butcher, had a comparatively low percentage of injury. There is also some indication that certain varieties are not infested as badly as others, although they have about the same growing period. This is strikingly exhibited by

Hildreth, which is one of the late varieties, but which shows a marked reduction in injury over Commercial White and White Democrat, two varieties requiring approximately the same growing period as Hildreth.

President Wilmon Newell: The next paper is "A Contribution Toward the Control of *Peridroma saucia* as a Tomato Fruit Worm," by C. L. Metcalf.

## A CONTRIBUTION TOWARD THE CONTROL OF PERIDROMA SAUCIA AS A TOMATO FRUIT WORM

By C. L. Metcalf, *Columbus, Ohio*

(Paper withdrawn for publication elsewhere)

Mr. George A. Dean: I should like to ask Dr. Metcalf if he used either lemons or oranges in the bran mash.

Mr. C. L. Metcalf: Not in this particular test, though they were used in some of the other experiments apparently with no attractiveness for the larvae over the mash without them.

Mr. George A. Dean: I will say that in Kansas we have had three rather serious outbreaks of the cutworm. We had one in 1909 when we made a miserable failure in the use of poison bran mash without the fruit juice, either lemons or oranges, which had not been used previous to that time. In 1914, when we had the large outbreak of both cutworms and army worms, the poison bran mash with lemons and oranges was used and this gave practically one hundred per cent. control. Again in 1919, when we had the great outbreak on alfalfa over the entire state, we used the poison bran mash with lemons and oranges successfully. In all these outbreaks the cutworm took on the habits of an army worm, going over the whole field, and in every instance where we used the bran mash with the fruit juice, we brought the insect under control. But in 1909 we had a miserable failure without it.

President Wilmon Newell: The next paper is entitled "The Pea Moth in Wisconsin," by Charles L. Fluke, Jr.

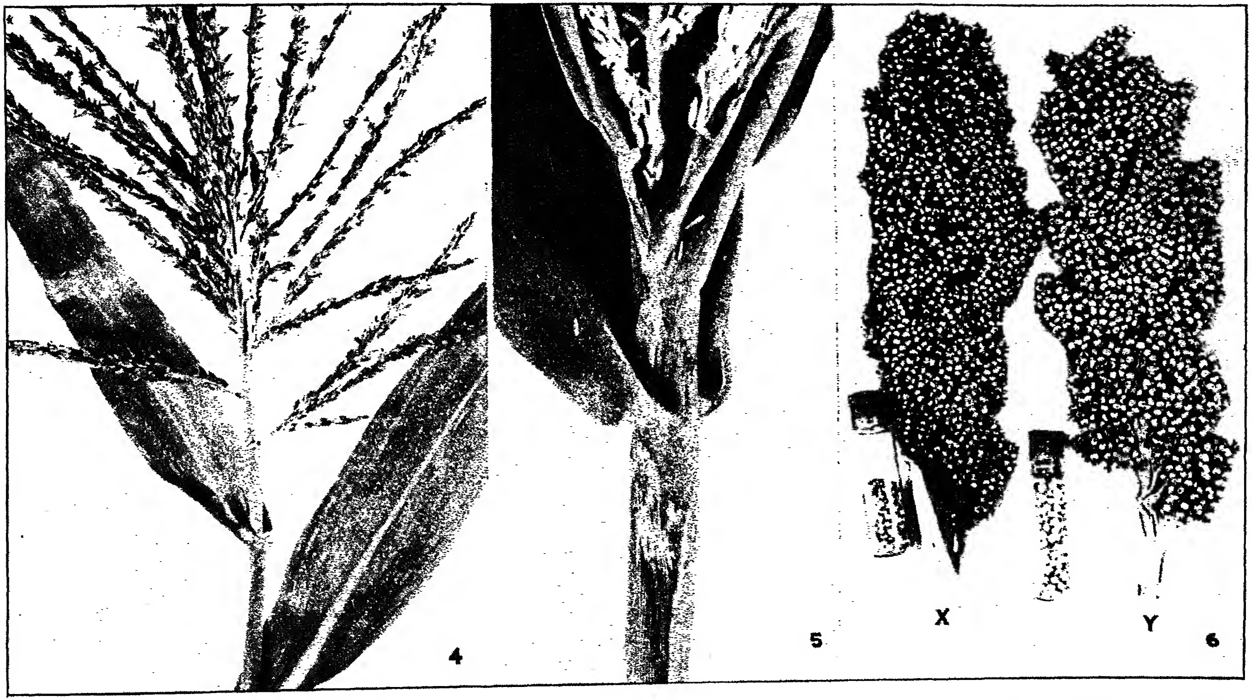
## THE PEA MOTH IN WISCONSIN

By Chas. L. Fluke, Jr., *University of Wisconsin, Madison*

The pea moth is one of the most serious pests of peas in northeastern Wisconsin. This insect is as important to the pea growers in the penin-

Plate 2


1. Tassel heavily infested with aphids: 2, Infested tassel which has failed to emerge from the boot; 3, Central branches of tassels; A, badly infested, with the spikelets gummed together preventing the shedding of pollen; C, Not infested, the spikelets have opened normally.




4, Normal tassel; 5, Stalk showing decay at base of tassel following aphid injury; 6, Heads of Kafir (X) from a stalk badly infested with aphids and (Y) from an adjoining uninfested plant. Each vial contains 300 seeds from the respective heads.

sular district as the codling moth is to the apple growers of Wisconsin. As many as 2 to 50 per cent. of the pods are infested each year, but unlike the codling moth there is as yet no known efficient remedy to check it.

Until just recently the pea moth of this country was known as the European pea moth—*Laspeyresia nigricana* Stephens, but according to Heinrich[10] our species is distinct and is now known as *Laspeyresia novimundi*. Except where indicated the data, here presented, covering life history studies were gathered during the 1920 season.

## Distribution

Mr. Heinrich suggests that "if *novimundi* is not a native species that has gone over to the pea from some wild legume, it has probably been introduced from the Orient." The first report of the destructiveness of a moth similar to if not the same as *novimundi* in this country came from Canada. Fletcher in 1895 reported it injurious in Ontario, Quebec, and the Maritime Provinces. In 1909 Chittenden,[7] reported the occurrence of the pea moth in Michigan.

The pea moth has been known to be destructive in Wisconsin for the past 15 years. One farmer in Brown County declared that he knew the insect as an enemy of peas some thirty years ago. From this evidence it is possible that it has been in the borders of the United States since about 1890.

## Characteristic Injury

The larvae of the pea moth injure the peas by boring into the pods and feeding upon the growing and ripening peas within. The young larvae make very tiny holes when entering the pods and these entrances are not observable after the larvae are within. The young feed upon one or all of the peas in each pod. Frass soon accumulates and this is webbed together and forms a filthy mass around the peas. Upon opening the pods the larvae are nearly always found within these masses and feeding upon the seeds which are near. There is no indication from the outside that the pods are infested; they must be opened to detect the presence of the worms.

Larvae have been found in the majority of cases in partly grown pods; however, numerous very young larvae were noticed in nearly ripe pods, even though there were immature pods still on the vines.

## Food Plants

If the pea moth in this country is a native species and indications at present are that it is, another food plant other than cultivated peas will probably be found. At present *novimundi* is known to attack only

field and garden varieties and is more particularly a pest of peas grown for the seed than those raised for canning, since the latter varieties are nearly always harvested before the moth begins its activities.

## Seasonal History and Habits

The winter is spent in the larval stage. On leaving the pods in late summer or fall, the larvae make their way a very short distance into the soil, forming a cocoon of soil particles webbed together and lining the interior with silk. The cocoon is not nearly as strong as the one formed by the codling moth. If stones are in the soil or old straw lying on the surface, the larvae attach their cocoons firmly to these objects.

In the spring, beginning about June 15th, the first pupae are formed and in about three or four weeks the moths begin to emerge. During the 1920 season the first moths were collected in the field July 12th, the same date the first ones were noticed in 1919. This past season moths were noticed in the field up to July 28. At this time the weather changed, becoming so damp and chilly that very little insect life was active. Within a week warmer days prevailed but diligent collecting secured no adult moths. Of the collected moths kept in the insectary the last one died August 5th. An average of 18 eggs per female was secured from 36 females in cages in the insectary.

About three days after the first moths emerged egg deposition began. In the field the majority of the eggs were found on young pods; quite a few on the leaves; a few on the sepals of young pods; some on the stems; and also a few on the leaves and stems of grasses growing in the pea fields. From the records of 278 eggs which were deposited in an outdoor insectary, the length of incubation period was found to be from 7 to 9 days with an average of 8 days. Within two days from oviposition the red streaks appeared and 5 days later the black spots were formed. In practically every case the eggs hatched the day following the appearance of the black spots. The percentage of infertile eggs was almost none.

The first eggs hatched July 23, the maximum number July 27, and the last ones August 11.

Under insectary conditions the first larvae emerged from the pods August 6, and they continued to emerge until August 29.

The larval period varied from 10 to 27 days with an average of 18.2 days.

From a study of the life history of this insect it is seen that it is inactive for nearly ten months of the year; only two months time being necessary for development from larval stage to larval stage.

## Remedies

As yet no practical method has been found that will control the pea moth in Wisconsin. Several sprays, mostly arsenical, have been tried; selections of early varieties, and the planting of these varieties at different times have also been tested but with no practical control results. There is a possibility of checking the pest by proper rotation of crops. The use of a good ovicide also remains for experimentation.

### Table Number I

| Total Females | Total eggs deposited in insectary | |
|---|---|---|
| | On Pea Leaves | On glass jars |
| 36 | 296 | 354 |
| | Total 650 | |

Average Number per ♀ 18.

### Table Number II

| No. of eggs | Date laid | Days before appearance of red spots | Days before appearance of black spots | Date hatched | Length of incubation period |
|---|---|---|---|---|---|
| 11 | July 15 | 2 | 7 | July 23 | 8 |
| 34 | July 16 | 2 | 7 | July 24 | 8 |
| 56 | July 18 | 2 | 6 | July 26 | 8 |
| 21 | July 19 | 2 | 7 | July 27 | 8 |
| 42 | July 20 | 2 | 7 | July 28 | 8 |
| 12 | July 21 | 2 | 7 | July 29 | 8 |
| 11 | July 22 | 2 | 7 | July 30 | 8 |
| 4 | July 25 | 2 | 5 | Aug. 1 | 7 |
| 27 | July 26 | 2 | 6 | Aug. 2 | 7 |
| 30 | July 27 | 2 | 6 | Aug. 4 | 8 |
| 25 | July 28 | 1½ | 7 | Aug 5 | 8 |
| 4 | July 29 | 2 | 8 | Aug. 7 | 9 |
| 1 | Aug. 2 | 3 | 8 | Aug. 11 | 9 |
| 278 | Averages | 2 | 7 | | 8 |

### Table Number III, Emergence of Larvae From Pods

| Date | Number Emerged | Date | Number Emerged |
|---|---|---|---|
| August 6 | 1 | August 18 | 5 |
| August 7 | 2 | August 19 | 4 |
| August 8 | 1 | August 20 | 4 |
| August 9 | 4 | August 21 | 6 |
| August 10 | 3 | August 22 | 2 |
| August 11 | 7 | August 23 | 4 |
| August 12 | 3 | August 24 | 4 |
| August 13 | 1 | August 25 | 3 |
| August 14 | 4 | August 26 | 0 |
| August 15 | 7 | August 27 | 1 |
| August 16 | 3 | August 28 | 2 |
| August 17 | 9 | August 29 | 1 |

Total—81

TABLE NUMBER IV

| | Length of Larval Period in Days | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| No of larvae .... | 2 | 3 | 3 | 5 | 5 | 4 | 4 | 8 | 7 | 8 | 7 | 8 | 6 | 3 | 4 | 2 | 1 | 1 |

Shortest period—10 days Total days 1474
Maximum period—27 days Total larvae 81
Average length of period 18.2 days.

REFERENCES

1. 1895—FLETCHER, J. Can. Exp. Farms Rept. for 1894, pp. 187–192. Reports injury to peas in Ontario, Quebec and Nova Scotia.

2. 1897—*Ibid* for 1896, pp. 228–9. In which he quotes a letter from a New Brunswick man as follows: "This pest has existed here at least forty years."

3. 1898—*Ibid* for 1897, pp. 194–5. Reports identification by C. H. Fernald, from a "greasy, unspread" adult specimen.

4. 1899—*Ibid* for 1898, pp. 191–2. The use of early varieties of peas as a control measure.

5. 1901—*Ibid* for 1900, p. 214. Suggests use of Paris Green.

6. 1902—CHITTENDEN, F. H. U. S. Bur. Ent. Bul. n. ser. 33, pp. 96–97. figs.

7. 1909—*Ibid* U. S. Bur. Ent. Bul. 66, pt. VII, p. 95. Occurrence in Michigan.

8. 1920—FLUKE, C. L. Wis. Agr. Exp. Sta. Bul. 310. Life History Studies, etc.

9. 1920—BRITTAIN, W. H. Proc. Ent. Soc. of Nova Scotia for 1919, No. 5, p. 11. Plate figuring egg, larva, pupa and adult.

10. 1920—HEINRICH, Carl. Canadian Ent. V. 42, pp. 257–8. "The Pea Moth a New Species."

MR. ALVAH PETERSON: I would like to ask Mr. Fluke if he had any idea why he cannot control this pest by arsenical sprays. He probably knows that in the case of the Oriental peach moth, the young larva when it enters the fruit or the twig, refuses to eat the outer portion. Have you noticed the entrance of these larvae and did they have the same habit? If they have the same habit, I would say that this accounts for the fact that you cannot control this pest with arsenical sprays.

MR. CHARLES L. FLUKE, JR.: In Wisconsin pea fields, the seed is sown in no particular drilling method. About the time the pods begin to form, the vines mat together, and it is almost impossible to cover the pods entirely with spray. The infestation is not sufficient sometimes to detect whether it comes from the lack of eating spray, or some other cause. I do not believe I can answer your question positively.

PRESIDENT WILMON NEWELL: We will now listen to the next paper, "Observations on the Fall Army Worm and Some Control Experiments," by Roger C. Smith.

## OBSERVATIONS ON THE FALL ARMY WORM AND SOME CONTROL EXPERIMENTS

By ROGER C. SMITH, *Manhattan, Kans.*

(Withdrawn for publication elsewhere)

MR. W. E. HINDS: This species occurred early in the season in Alabama. This year, every county in the state had two or three generations. The second and third generations cause the severe damage. Those in Kansas are probably due to migration from the southern area.

MR. GLENN W. HERRICK: I would like to ask if it is positively known that all of these hundred larvae were parasitized.

MR. ROGER C. SMITH: Yes.

PRESIDENT WILMON NEWELL: The next is a paper by W. J. Baerg, "A Girdler on Artichoke and Other Little Known Insect Pests."

## A GIRDLER ON ARTICHOKE AND OTHER LITTLE-KNOWN INSECT PESTS

By W. J. BAERG, *University of Arkansas*

*Mecas inornata* Say (Order Coleoptera, family Cerambycidae). This beetle, half an inch long, of a light gray color, is a girdler that attacks artichoke (*Helianthus tuberosus*). The beetles begin ovipositing early in July. The females when laying eggs girdle the main stem about six inches from the top. Two girdles are made, about 1–1¼ inches apart. Immediately above the lower girdle is the egg puncture. This is exactly similar to the method followed by the Raspberry cane girdler (*Oberea bimaculata*). The girdles are not clean cuts such as we find in woody plants, but rather a series of holes encircling the stem. Apparently one female will deposit in a large number of plants. In spite of the fact that only a few beetles could be located, practically all the plants in the field were attacked in the course of a few days.

As a result of the injury, the leader in the plant dies and the plant develops a bushy type of branching.

The young larvae upon hatching begin to feed between the girdles and later proceed towards the base of the plant. They confine their injury largely to the pith. Apparently under certain weather conditions the artichoke is not well fitted as a host plant. In only one out of four or five plants showing egg punctures was there a full grown larva.

In most of the other plants the larva had begun to feed and some time later died, presumably it had been injured by the growing stalk.

The larvae attain full growth, that is about seven-eighths of an inch in length, some time in November. At this time the larvae are found at the very base of the stalk, about two inches below the surface of the ground, in an enlargement of the tunnel which has been padded with fine bits of pulp.

The pupal stage has not been observed but since the adults appear early in July, the larvae will presumably pupate some time in May or early in June.

It seems reasonable to assume that this species will attack most of the species in the genus Helianthus. None of these were near the artichokes, and no data have been secured. The only host plant other than artichoke that could be located is the common ragweed (*Ambrosia artemisiifolia*).

*Haploa colona var. reversa* Stretch (Order Lepidoptera, family Arctiidae.) The caterpillars appeared on strawberries early in April. In the neighborhood of Johnsons some beds were infested to such an extent as to make the injury very noticeable, about 10 per cent. of the foliage was destroyed. The larvae resemble in a superficial way those of the Peacock butterfly. They were nearly fullgrown on April 19. Specimens reared in the insectary emerged as adults about a month later.

*Eleodes tricostata* Say (Order Coleoptera, family Tenebrionidae). The life history of this species has been studied in Kansas and among several other species is recorded by Professor Dean as of "great economic importance". (Station Rpt. 1917–18). The larvae were sent in from De Queen and reported as damaging strawberry plants. An investigation showed that the larvae attacked the crown, and the roots immediately below the crown. It was only in new beds, such as had been set out that spring, where the injury appeared. The field in which the heaviest damage was observed was a piece of cleared woodland. Here the larvae destroyed fully 50 per cent. of the young plants over an area of several acres. Some of the larvae were taken to the Insectary at the Experiment Station and reared in Riley cages. The adults appeared late in July.

All the insects referred to in this paper were determined through the kindness of Dr. L. O. Howard, United States Bureau of Entomology.

Adjournment.

## Section on Apiculture

*(Wednesday Evening)*

The meeting of the Section on Apiculture of the American Association of Economic Entomologists was held Wednesday evening, December 29, 1920, at the University of Chicago, and was called to order at 8.15 p. m. by the Chairman, Mr. F. B. Paddock of Ames, Iowa.

SECRETARY G. M. BENTLEY: It becomes my duty to introduce the first speaker of the evening, our Chairman, Mr. Paddock. He will address us on "Better Queens."

## THE VALUE OF GOOD QUEENS

By F. B. PADDOCK, *Ames, Iowa*

Increased production and efficiency of production are terms which have come to mean a great deal to all of us during the last few years. Among beekeepers these terms have less meaning than among most any other class of producer. Several factors are needed to place honey production on a sound basis. To even enumerate the more important factors is without the scope of this paper. Only one factor is given for consideration; better queens.

During the past season observations have been made in an apiary which was originally composed of 60 colonies. The start was made by the purchase of 40 3-frame nuclei and 20 3-pound packages. All of the bees arrived and were installed about April 27. The queens were raised in the period just preceding shipment. In the two weeks following installation some queens were lost and such nuclei were distributed, a frame or so in a place, among the remaining nuclei. Since all the bees were in the same yard, all placed on foundation, all fed apparently equal, all given any and every attention possible, it can be said that the environment of the colonies was as nearly equal as it is possible to provide.

On June 6th an examination was made of the 14 colonies originating from packages and the 31 colonies originating from nuclei. A more or less arbitrary standard was used but the ratings were applied equally in every case. These were Excellent for those colonies with 6 frames of brood, Good for 5-frame, Medium for 4-frame in modified Dadant hive.

Of the package colonies on June 5th, 12 were rated as Excellent and 2 as Medium. The results of the season in honey gathered are shown in Table I. Of the 2 Medium colonies, 1 produced no surplus honey and 1 produced ½ super. A full modified Dadant super is taken to

yield 40 pounds of extracted honey. But little more could have been expected from these colonies although unlimited patience was shown toward them with the hope that conditions might improve.

TABLE I

| | | | |
|---|---|---|---|
| 20 colonies | | | |
| 6 loss | | | |
| 14 | | | |
| | 2 Medium | 1–0 | |
| | | 1–½ super | |
| | | 2–½ | |
| | | 2–1½ | |
| | | 1–2½ | |
| | 12 Excellent | 5 | 6½ supers |
| | | 5–3 | |
| | | 2–4 | 23 supers |
| | | | 29 supers |

Of the 12 colonies rated as Excellent the results are as interesting as erratic. Two colonies produced ½ super each, two 1½ supers each, one 2½ supers, five 3 supers each and two 4 supers each. It will be seen that five of the twelve which were rated as Excellent produced less than the average or 1.3 supers each. On the other hand seven of these twelve colonies produced more than the average or 3 2-7 supers each. Then the seven colonies produced 3.6 times as much as the five, or 85 per cent of the total crop. If all package colonies had produced 3 supers each (the amount produced in 5 cases) the 14 colonies would have produced 42 supers of honey instead of 30 or an increase of 40 per cent or 480 pounds having a market value of $120. This amount of money was lost to the beekeeper the past season because all the colonies did not produce an average return.

TABLE II

| | | | |
|---|---|---|---|
| 40 | | | |
| 9 loss | | | |
| 31 | | | |
| | 1 Poor | | |
| | 13 Good | 7–½ | |
| | | 4–1½ | |
| | | –2 | =13½ supers |
| | | 2– ¼ | |
| | | 2– ½ | |
| | | 4–1½ | |
| | | 2–2 | |
| | 17 Excellent | 10 | 11½ supers |
| | | 5–3 | |
| | | 1–4 | |
| | | 4–5 | =24 supers |
| | | | 35½ supers |

Of the nuclei colonies on June 5th, 1 was rated as Poor, 13 as Good and 17 as Excellent. The results of the season in honey gathered are shown in Table 2. Needless to say the poor colony did not produce any surplus honey. Of the 13 good colonies, seven produced ½ super each, four 1½ supers each and two 2 supers each. Then the thirteen colonies produced 13½ supers of honey or an average of 1 7-13 supers each. Ample attention was given to these colonies but day after day did not bring the fond realization of the dream that tomorrow they would pick up and do well.

Again in those colonies rated as Excellent at the beginning of the honey flow the results were exceedingly variable. Two of these colonies produced ¼ super, two ½ super, four 1½ supers, two 2 supers, five 3 supers, one 4 supers and one 5 supers. Thus ten of the seventeen Excellent colonies produced below the average, a total of 11½ supers or 1.15 supers each. The other seven colonies produced above the average with a total of 24 supers, or 3 3-7 supers each. With these colonies as with the package colonies, the majority of those producing above the average produced 3 supers each. Only 33 per cent. of the package colonies produced the average amount of honey. The seven Excellent nuclei colonies produced an average of three times as much as the average of the other ten, or they produced 75 per cent. of the total crop of this class. If all the nuclei colonies had produced the normal of the best or 3 supers, the yield would have been increased almost 100 per cent. or 1760 pounds worth \$440. In the entire yard the loss to the beekeeper by these low producing colonies was \$560. There were 31 colonies involved in this loss or \$18 was the loss on each colony. In other words each poor queen cost the beekeeper \$18 in one season, the market price of one dozen queens at present.

Having stated the effect, is it possible to state the cause? The queens of either the 40 nuclei or the 20 packages were raised in the same yard and all the queens were doubtless raised at approximately the same time, since delivery was practically the same. On June 5th, or just previous to the main honey flow, the colonies were rated. The difference in the condition of the colonies at this time could be attributed to several causes, more or less within the control of the beekeeper. However, the cause at this date is the same as poor producing colonies and will be referred to later. This cause may not be so pronounced before honey flow begins.

Reference to Table 1 will show 12 colonies rated as Excellent on June 5th of which only 7 produced an average crop as indicated on August 5th. Reference to Table 2 will show 13 rated as Good and 17 as Excellent, of which only 7 produced an average crop. What can the answer be? Queens of a low producing type.

Queen breeders may take exception to this solution of the problem presented. However, the time is at hand when the beekeeper needs queens raised from a production record rather than color, gentleness, character of capping and several features now pointed to with pride by this or that queen breeder. In other forms of production we have a basis of reproducing from individuals of a known record. In the development of the 265-egg hen each progeny has been selected for breeding purposes on a basis of high performance. The same is true with dairy herds and racing horses. We now hear of poultry culling with the attendant "boarder hens" and we hear of the Babcock test with "boarder cows". Why not hear of pounds of honey and "boarder queens"?

The problem of improving the queens on a basis of production may be slow and uncertain but the improvement must come in bees as it has in the other animals. The problem may be complicated by the asexual development of drones and the inability to control mating. However, effort must be made to overcome the present indifferent production of queens. Individual selection will be required and progress at first will necessarily be slow.

In the meantime each beekeeper can help in this problem. Rate the colonies and check them closely. Any colony which does not come up to average should be requeened. Provide a queen reservoir so as to have queens to replace in case of accident or slump. In August requeen all colonies that are not up to the average. Such measures are only temporary at best. Improvement must be on a sound basis of heredity. The real solution of this problem lies in rearing queens on an individual record of performance basis.

Mr. H. F. Wilson: I would like to ask if that was this year.

Mr. Paddock: They were spring raised queens and arrived with the nuclei and packages approximately April 25th.

Mr. Wilson: We had practically the same experience. There were twenty-seven queens out of ninety that failed, that is, died from one cause or another. I presume that you noticed practically every one of those colonies started to requeen itself.

We found in the case of package bees that every colony, practically, will start to supersede. We found, for instance, that when bees come in as early as April 20th, the loss will be from ten to fifteen percent. more than if the bees arrived on May first. I am just wondering whether or not we can figure correctly the value of queens that come in packages. That the queens should be tested out can not be questioned, but if those queens had not been shipped in, would the results have been as bad?

Last year we got packages about the first of May and we did not lose a single one, but this year we lost twenty-nine out of ninety. We attribute that to the fact that when it was cold the bees would not take care of them.

CHAIRMAN PADDOCK: The next paper on the program is "Some Apicultural Investigations" by Wallace Parks of Ames, Iowa.

## SOME APICULTURAL INVESTIGATIONS

By WALLACE PARKS, *Ames, Iowa*

(Withdrawn for publication elsewhere)

MR. E. C. COTTON: I would like to ask Mr. Parks if he knows if those bees that made a few trips had larger loads than those that made many trips.

MR. PARKS: I am inclined to believe that in most cases the bees making very few trips were old bees.

CHAIRMAN PADDOCK: The next paper is by Mr. L. V. France.

## THE PROBLEM OF CONTROLLED FERTILIZATION OF QUEEN BEES[1]

By L. V. FRANCE, *University Farm, St. Paul, Minn.*

This problem is without doubt the most important one which has to be solved before the pursuit of beekeeping, or industry, if it can be called such, may advance farther than its present stage. We know fairly well how to manage the honey bee, in her present more or less hybrid and variable condition, for surplus honey production. We are also able, after a fashion, to control the bee diseases and keep the winter loss down to about ten per cent. (10%). In an apiary of one hundred colonies of the purest breeding possible at present, we find a few colonies that surpass all of the others in honey production, gentleness, comb building and wax production qualities, resistence to certain diseases, hardiness, length of life, etc. For the *one single reason* that we are not able to control the mating of our queen bees we cannot keep and combine these desirable characteristics when they once appear in one or more colonies.

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[1] Published with the approval of the director as Paper No. 238, of the Journal Series of the Minnesota Agricultural Experiment Station.

An illustration of this occurred about 1906. E. R. Root discovered one of his colonies of bees working on red clover when all other colonies were doing nothing. Investigation showed that the tongue length of the bees of this colony was twenty-three one-hundredths (23-100) to twenty four one hundredths (24-100) of an inch while the tongues of ordinary bees are sixteen one-hundredths (16-100) of an inch to seventeen one-hundredths (17-100) of an inch in length. This particular sport colony degenerated back to the normal stock, although an attempt was made to save the long-tongue character. (E. R. Root, Jour. of Heredity, Vol 7, No. 1, Jan. 1916. Page 46).

The solution of this problem requires a knowledge of bee behavior and of the morphology and physiological reactions of the generative organs. The data of real value which are now available are meagre and it is apparent that a successful solution of this problem necessitates a very large amount of further study and investigation.

When we are able to definitely control queen bee matings, there will then be available for genetic or heredity studies an animal offering probably greater opportunities for results than has the fruit fly, Drosophila. This one possibility alone would be worth more to the people of the United States than all the honey produced in this country.

About 1800, F. Huber, in France showed that the queen bee is mated in the open air, on the wing, and that this fertilization may last for several years.

In 1745 Bonnet described parthenogenesis in plant lice. About 1845 Dzierzon in "Eichstädt Bienenzeitung" stated his theory that drone bees develop from unfertilized eggs.

The movable frame hive invented about 1851, Italian bees introduced from 1861 on, the honey extractor about 1860, comb foundation about 1857, a practical bellows smoker about 1865, and great crops of honey secured from bees created such an interest that the American Bee Journal began its publication in 1865 during the Civil War.

It was soon apparent that it was difficult to keep pure the Italian bees or any of the other races being introduced, Carniolan, Caucassian, and Cyprian especially, because of the almost universal presence of common black or German bees within a mile or so of any conveniently located queen breeding apiary. The desire also developed to produce breeding stock of the different races of bees, emphasizing gentleness, honey gathering qualities and color markings.

From 1870 to perhaps 1900 the dream of beekeepers as noted especially in the American Bee Journal was to control the mating of the queen so that races and strains could be kept pure and desired qualities obtained and propagated.

An investigation of the literature has given to us a list of about thirty references of attempts to control queen bee matings. These attempts are of two general types, *first*, enclosure of some sort to permit a more or less natural meeting place for a queen and a drone, including various small glass covered boxes on hives, tents and greenhouses, one of the latter being the largest glass building in America; *second*, the more or less forcible mating of the queen by bringing a queen and drone together and then forcing out the drone's organs by pressure on the abdomen, or by forcible injection of drone sperms or sperm fluid into the vagina of a virgin queen.

Considerable interest was directed towards Minnesota in 1914 when Jager and Howard secured one successful mating out of six trials by this last mentioned method, injection of sperms into the vagina of the virgin queen. In 1915 and 1916 however, Prof. Howard and myself secured only three partial successes out of fifty-five attempts and we concluded first that to continue further by that method would necessitate more study of the morphology and functioning of the sexual organs and second, that a different method would be more likely to yield immediate results. I tried a certain kind of a tent in a greenhouse at University Farm in 1918 and failed to mate the virgin queen used but secured some valuable data.

The latest and one of the most valuable contributions to the solution of this mating problem appeared in the Journal of Experimental Zoology for August 1920 in the form of two very excellent papers by G. H. Bishop of the Entomology Division, Wisconsin University, on the morphology and probable physiological functioning of the generative organs of the drone and queen.

It is our opinion that bee culture may have reached its probable development under the present conditions. Our so-called pure Italians seem at best to be something of a mixture. Controlled mating of queen bees will permit actual "pure" races and strains to be produced. When we have them, then with the proper breeding procedure it will be possible to create a honey bee that is uniformly gentle, hardy, long life period, great honey gatherers, resistance to disease, etc. on to our "ideal" bee for Minnesota and the Northwest.

I feel very confident that someone in the near future will devise some method whereby matings may be controlled. We expect the solution of that problem will give bee culture as great a step forward from its present stage as the invention of the movable frame hive did in 1851.

Finally we feel at times that if it were permissible and we could "get away with it" as so many seem to be doing just now, we would rob a bank, build a large, high domed green-house similar to the one in Como

Park, St. Paul, to permit a twelve months experimental period, and probably we might be able to make a contribution.

## References With Brief Data


? H. L. Jeffrey. Confined in several hives of bees were some virgin queens and drones of selected stock. These hives had above the combs a space three to four inches high free and clear, to give the bees room in which to gather when being moved, it being the intention to take them some distance from other bees and there liberate them, trusting that the matings of the queens would be with the selected drones. The hives were moved by wheelbarrows, and on inspection at the end of the journey he found that all six queens had mated. Subsequent similar attempts failed. Mr. Jeffrey is credited with being a close observer. R. I. Agri. Exp. Sta. Report 1908—p. 306.

? W. E. Flower. Cage of mosquito netting about 15 x 15 feet. One successful mating. R. I. Agric. Exp. Sta., Report 1908—p. 307.

1873 J. Hasbrouck. Small glass covered box on hive. Many queens fertilized, also many failures. *Am. Bee Jour.* Vol. 14—1873.

1875 J. Hasbrouck. Small glass covered box on hive—three matings. *Am. Bee Jour.* Vol. 15—p. 519.

1875 Davis. Small glass covered box on hive—one mating. *Am. Bee Jour.* Vol. 15.

1875 Bagley. Small glass covered box on hive—one mating. *Am. Bee Jour.* Vol. 15.

1878 J. Hasbrouck. Small glass covered box on hive—several matings. *Am. Bee Jour.* Nov. 1878.

1881 Cramer. Small glass covered box on hive—two matings. *Am. Bee Jour.* Vol. 17, p. 19.

1881 Fincastle. Small glass covered box on hive—five matings. *Am. Bee Jour.* Vol. 17.

1882 Shuck. Queen tied to thread so she could fly only above the home apiary—one mating. *Am. Bee Jour.* 1882, p. 789

1884 Brown. Small glass covered box on hive—one mating. *Gleanings in Bee Cul.* 1884. p. 674.

1885 Cook. In hive. Queen had imperfect wings—one mating. *Gleanings in Bee Cult.* Vol. X, p. 544.

1887 McLain. Large tent—one mating of 6, later 3 of 6. *Am. Bee Jour.* Vol. 23, 1887.

1888 McLain. Large tent—six matings. *Am. Bee Jour.* Vol. 24, p. 487.

1887 McLain. Squeezing drops of sperm fluid from drone organ into vulva of queen—twenty-five matings. *Am. Bee Jour.* Vol. 23.

1887 McLain. Squeezing contents of seminal vesicles into vulva of queen—three matings. *Am. Bee Jour.* Vol. 23.

1887 McLain. Diluting sperm fluid with introduction into vulva—six matings. out of twenty-seven. *Am. Bee Jour.* Vol. 23.

1885–6 McLain. Various methods as above. Reports U. S. D. A. 1885 and 1886.

1887 McLain. Various methods as above. Reports U. S. Com. Agr. 1887.

1887 Hohenshell. Greenhouse—two matings. *Am. Bee Jour.* Vol. 23, 1887.

1887 Balch. Squeezing drops of sperm fluid from drone organ into vulva of queen. Had practiced this on defective winged queens for fifteen years. *Am. Bee Jour.* Vol. 23, 1887.

1901 J. S. DAVITTE of Aragon, Ga., used a tent of mosquito netting, 30 feet high and 30 feet in diameter. Colonies of bees containing selected drones and queens of mating age were placed at the bottoms of such enclosure with the outside entrance covered with queen excluding perforated zinc and an inside entrance opened from 11:00 a. m. to 1:30 p. m. on favorable days. *Davitte reported 100 successful matings.* This general plan has been tried by others but without success. One man used wire cloth instead of mosquito netting and the queens, drones and workers killed themselves on the screen. Davitte's cage was wrecked by a wind storm and not rebuilt. *Beekeeper's Review*, Feb. 1901 and R. I. Agri. Exp. Sta. report, 1908, p. 307.

1903 E. F. PHILLIPS. Glass covered vivarium, Univ. Penn. Nuclei containing drones and queens had outside entrances protected with perforated zinc and unprotected inside entrances. Drones were used that had never flown outdoors. Observations were taken from the rafters. The queens would soon strike the glass roof and alight and the drones would at once disperse, there apparently being no attraction in a queen at rest. No matings. *Beekeeping.* E. F. Phillips, 1915, p. 69–70.

1907–8 A. C. MILLER and L. J. COLE. A cloth tent nine feet square, nine feet high, double walled, the cloth walls one inch apart permitted bees to fly in apparently a normal manner. Several trials with no matings. The queens struck the top a great deal in flying. The drones did not strike the top but flew freely. It may be the drones failed to recognize the queen because of the presence of many flying workers or if recognized mating failed to occur because of unfavorable conditions, such as confinement and limitation of vertical space permitting reaction of the queen to the drone. R. I. Agr. Exp. Sta. Report, 1908. p. 306–311

1915 WILMON NEWELL. Controlled matings at isolated bee-free stations on the Texas Gulf Coast Prairie. Natural matings in the air. Successful crossing of Italians and Carniolans. *Science*, n.s. 41; No. 1049, 218-219.

1915 JAGAR and HOWARD. Diluting sperm fluid and using pipette to introduce the fluid into the vagina—one mating of six. *Science*, n.s. Vol. 40, No. 1037, p. 720.

1915–16 HOWARD and FRANCE. Diluting sperm fluid and contents of seminal vesicles of mature drones and introduction with pipette into vagina. Three partial successes of fifty-five. *Jour. Ec. Ent.* Vol. 11, No. 2, p. 265–267.

1915–1916. C. E. BARTHOLEMEW. Personal statements to C. W. Howard and L. V. France that he had at Ames, Iowa succssfully mated several queens by forcing the contents of the drones sexual organs into the vagina of receptive virgin queens. This item unpublished so far as is known.

1917 GEO. D. SHAFER. (a) Virgin queen and drone were each fastened at end of a fine elastic wire holder. With wings buzzing queen and drone were brought face to face in the air. No matings from several trials.
(b) Forcing out drone sexual organs into vagina of queen. No matings from several trials. Tech. Bull. 34, Mich. Agr. Exp. Station.

1917 E. R. ROOT. "So far the only feasible plan for mating queens with select drones is to put perforated zinc over the entrances of all colonies not having choice drones, leaving only select drones to have the freedom of the air. A still better plan is to take the queen mating nuclei to an island where there is a colony containing select drones. This island should be located at least five miles from the mainland." 1917 Edition, A. B. C. of Bee Culture, A. I. Root Co., Medina, Ohio.

1917 H. H. & E. R. ROOT. Garden truck greenhouse. Largest glass building in America 600 feet long, 60 feet wide, and 30 feet high. No matings from 24 queens.

1917 H. H. & E. R. ROOT. "As a final word we give it as our opinion that while this experiment is not absolutely conclusive yet we feel that if mating under cover is ever accomplished the percentage of mating may be so low that the success will be interesting more from a scientific than from a practical viewpoint. In other words, while the queens and drones may fly naturally in a great enclosure like the greenhouse in which this experiment was tried, yet conditions nevertheless are not normal, as they are out of doors, and any possible successful matings will doubtless be limited. Yet having said this we are not quite prepared to add that this cannot be done. We may try the experiment again—indeed we are likely to try it again." *Gleanings in Bee Culture*, Vol. 45, No. 1, to 7; January-July, 1917.

1918 L. V. FRANCE. Round canvass tent, double walls, 4 feet in diameter, 7 feet high at peak with about 8 inches space between the canvas walls. A nucleus, containing workers, drones and a five day old virgin queen was placed in the tent and observations taken. No natural, mating flights occurred. The Virgin appeared to fly naturally in the tent, returning unaided to the hive, when removed from the nucleus and thrown into the air. The drones appeared to fly naturally, more so at first than after several days confinement in the tent. The queen failed to mate. Temperature ranged from 64 degrees F. to 92 degrees F. *Science* n. s. Vol. 49. No. 1255, January 17, 1919.

1920 GEO. H. BISHOP. Two methods used as in the past.

1. "Queen and drone held in juxtaposition and the extension of the drone's organs brought about by pressure on the abdomen."

2. "The seminal fluid of the drone was dissected out and injected with a pipette into the organ of the queen." No successful matings. *Jour. Exp. Zool.* 31; No. 2; Aug. 20, 1920, pages 225–266; 267–286.

1920 F. W. L. SLADEN. Mating queens successfully with selected drones on Duck Island, Lake Ontario. *Gleanings in Bee Culture*, 48; 80–82, 717–718, 1920.

CHAIRMAN PADDOCK: The next paper is by Dr. J. H. Merrill. Dr. Tanquary will read the paper.

## FURTHER NOTES ON THE VALUE OF WINTER PROTECTION FOR BEES[1]

By J. H. MERRILL, *Apiarist*

*Kansas State Agricultural College and Experiment Station*

For the past three years an experiment has been carried on at the Kansas State Agricultural College to determine the best method of wintering bees. The results of the first two years' work were published

[1]Contribution No. 61, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 126 of the Agricultural Experiment Station.

in the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 13, No. 1, pages 99 to 111. In this report it was explained that two series of hives were used in this experiment, one of which was placed in the open, and the other was placed so that it was protected by a dense windbreak. In each set there were used one one-story hive, one two-story hive, and another two-story hive, which was placed in a packing box and insulated with leaves, whereas the one-story hive and the two-story hive were left unpacked.

As a standard of what constitutes good wintering, it was decided that that colony which possessed the greatest number of bees at the beginning of the honey flow was the one which had wintered best. In the fall of the year, and again in the spring, by a system of weighing, and allowing 5000 bees to a pound, it was possible to very closely approximate the total number of bees in a colony and the amount of honey both in the fall and in the spring. The results for the first two year's work conclusively showed that a two-story hive gave better wintering results than a one-story hive. Since this was due to a greater depth, making it possible to leave more honey, and also provide room for clustering and spring brood rearing, then, for the same reason, a larger and deeper hive would be preferred even to a two-story hive, because it would have the extra room and depth in one set of frames. It was also shown that the difference between a packed and an unpacked colony was represented by about 25000 bees, or five pounds. With bees selling at $2.50 a pound, this would mean $12.50 saved by using the packing. The windbreak was shown to make a difference with the unpacked colonies of about 2500 bees. With the packed colony, however, the windbreak was not as valuable, showing that if a windbreak was not available, packing, to a large extent, would take its place.

Ordinarily, in the vicinity of Manhattan, Kansas, the elms begin blooming about the second week in March, followed by the soft maples, after which other spring flowers, that is, fruit bloom, etc., appear. Usually it would be necessary to leave only stores enough in the hive to last the bees until April, after which time, unless the weather is unfavorable, the bees will gather sufficient honey for spring brood rearing. The spring of 1920 was very cold and unfavorable. On the 5th day of April, the temperature at Manhattan dropped to five degrees above zero, killing not only the flowers which had already appeared, but so seriously injuring the buds as to prevent the later flowers from appearing. Consequently, the bees were obliged to subsist almost entirely on honey which was left in the hive in the fall.

The bees were put into winter quarters on October 4th, 1919, and the number of bees and amount of honey in each colony was computed.

During the winter, as each colony rested on a platform scale, daily weights were recorded. On the 19th of May, the packing was removed from the hives and the number of bees and the amount of honey in each hive was again computed. The 19th of May is two weeks later than the date when the spring weights were taken in 1919, and if the queens had been laying 3000 eggs a day, the colonies should have each had 42,000 more bees this year at the time of weighing than during 1919.

The results of the spring weighings in 1920 differed in a great many respects from the preceding years, and at first glance appeared to be unexplainable. However, as will be mentioned later, an examination of the weights taken daily very satisfactorily explained the seeming differences. As in the previous years, the two-story hive and the packed hive in the open were found to be far superior to the one-story unpacked hive. Also the windbreak was shown to be very valuable, as the colonies, with the exception of the packed colonies in the windbreak, were far superior to the similar colonies in the open. The most surprising discovery was that the packed colony had not gained as many bees as the unpacked colony. This was at first very disconcerting, but upon turning to the record card which contained the daily weights taken of these colonies, it was found that on the 19th of April, the packed colony had completely exhausted its winter stores, and from that time until the 19th of May the bees were obliged to subsist on what few flowers they could find. The one-story unpacked hive had been able to continue making its gains, due to the fact that on the 19th day of May it still had a considerable amount of stores left in the hive. Similar conditions were found with the packed colony in the open. It had gained over what it had in the fall, but in no way was this gain equal to that made by this same colony during the previous years. In 1918–1919, the one-story unpacked hive in the windbreak gained 313 bees, while the packed hive in the windbreak gained 24,844, but during 1919–1920 the one-story unpacked hive in the windbreak gained 10,000, while the packed hive similarly placed gained only 3700. In 1918–1919 the two-story hive in the windbreak gained 5936, whereas in 1919–1920 it gained 8125. In 1918–1919 the packed hive had 24331 more bees than the unpacked hive, but in 1919–1920 it had 6300 less. Had it not been for the fact that daily records of the changes of weights were kept, these results would have been very hard to account for, and the general opinion that packing was not always of value would have been justified. On the 19th of May, the unpacked hive had five frames of brood, whereas the packed hive had only about three, yet to all ordinary appearances, the packed hive was a good, strong one on the 19th of May, and to a casual observer it would appear that they had wintered well. However,

when the fact is taken into consideration that during the fall and the spring of the previous year this colony gained 24844 bees, and this year it only gained 3700, it can be seen that something was radically wrong. A clue to this condition is found in the fact that the one-story unpacked hive had five frames of brood, while the packed colony had only three. This would account for the weakened condition of the hive. It is a well known fact that when the honey flow stops, most queens cease brood-rearing, or at least let up in the number of eggs deposited. From the results obtained this year, we see that a very similar condition is brought about in the hive when the stores are becoming exhausted. The queen slows up in her egg-laying to such an extent as to greatly weaken the colony, yet not enough but what it will appear to the casual observer to have wintered satisfactorily. If the honey flow should begin early enough, this colony will then go ahead and develop into a strong colony before the season is over. However, the opportunity of gathering a large surplus that year has been lost, because the colony would not be ready at the time the honey flow began. As an indication of the amount of food that the bees consumed during the winter of 1919–1920, it might be stated that one colony between October 4th and May 19th consumed 52¾ pounds of honey, six pounds of sugar, and two Langstroth frames partially filled with honey. When the difference between the packed hives and the unpacked hives is taken into consideration for the first two years, then it would be a mere matter of arithmetical computation to obtain the number of bees that would have been in the packed colonies this year had they been as well provided with stores as the unpacked hives.

Some valuable lessons may be drawn from the results obtained in the spring weighings, among which are: (1) When a colony has insufficient stores, even though it may appear to winter well, it will not be up to its full strength at the beginning of the honey flow, owing to the fact that the queen ceases brood-rearing when stores in the hives are becoming scarce; (2) it emphasizes the fact that although packing is very valuable, too much emphasis should not be placed on this feature alone, and (3) the windbreak was again found to make a great difference in the number of bees in each colony at the beginning of the honey flow, but, as before, this result was not as noticeable in the packed hives as in the unpacked hives.

When considering the question of wintering bees, too much emphasis should not be placed on any one feature alone. We know that we must have a large number of young bees; that we must have plenty of stores, and also that if we can give our bees the added value of a windbreak and winter protection, it will well repay us, but no beekeeper should

rely on any one of these factors alone and expect to get the very best results. They are all necessary.

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CHAIRMAN PADDOCK: The next paper on the program is by Frank C. Pellett.

## SOME BEEKEEPING PROBLEMS FOR EXPERIMENT STATIONS

By FRANK C. PELLETT, *Hamilton, Ill.*

The experiment stations are justly entitled to a large share of the credit for the great advancement of agriculture during the past few years. Unfortunately, as yet, few stations recognize the problems of the honey producer as of sufficient importance to engage their serious attention. Iowa and Texas are the two outstanding exceptions, for in these two states full time men are devoting their undivided attention to research work. However, in both cases, the work is new, and sufficient time has not yet elapsed to get far with the problems at hand. In several other states some research work is under way in charge of the entomologist or of some one on the staff who devotes a portion of his time to beekeeping.

For the most part the progress of apiculture is to be credited to the work of enthusiastic beekeepers who have made accidental discoveries and to well trained men who have taken up beekeeping as a hobby. The results obtained by the staff of the Bureau of Entomology of the U. S. Department of Agriculture, in their wintering experiments and in their research work on bee diseases, would surely indicate that beekeeping offers a promising field.

Since beekeeping is now receiving more favorable notice from the colleges of agriculture and state experiment stations, as evidenced by the fact that in more than thirty states some work in beekeeping is now under way, it may be an opportune time to point out a few of the problems which might profitably be undertaken.

The two problems which have received the most attention, wintering and bee diseases, may be mentioned. While much has been learned concerning the activities of the bees in winter and the fundamentals that must be observed, there is still a lack of such information as will enable the average beekeeper to apply these principles to his specific conditions. In every state it should be possible to give the enquiring beekeeper definite information as to the best method of wintering in his particular locality. Kansas is just now making an attempt to work out this information for the beemen within her borders.

We owe much of our information relating to the cause of larval diseases of the bees and their treatment to the Bureau of Entomology, although valuable information concerning the treatment was worked out by practical beekeepers. This knowledge came just in time to save the industry. There are, however, apparently, several diseases of the adult bee which at times cause heavy losses. We do not know, as yet, whether there be one or two, or a dozen of these diseases, nor do we know the cause. There is room for much work in this direction.

## Some Practical Questions

In the sixties much interest was aroused in the possibility of securing a better race of bees than the black bees then common in this country. The Italians were imported and given much attention on the part of the bee magazines and the leaders in the beekeeping field. They proved to be much superior to the others and have been gradually replacing them since that time. For a number of years this interest in new races of bees continued and several men made long journeys to Europe or Asia in search for better bees. Cyprians, Egyptians, Caucasians, Carniolans and several others have been brought to this country at one time or another and given a limited trial. Perhaps the general introduction of these bees into the apiaries of the country, where they were left to chance in most cases, may be a sufficient trial. It would seem, however, that it might be quite possible that the best race of bees for California would not prove equal to some other for New England. There are several varieties of the honeybee which should be given an extensive trial under different climatic conditions to ascertain their possible value for America.

The problem of improving our best strains by selection and breeding should receive serious attention. One season, in the writer's apiary, there was a colony of Italians that continued to store surplus honey during a period of dearth when the rest of the apiary was doing little and some colonies were requiring feed to keep them from starvation. These bees were found to be working freely on a field of red clover near by. The tongues of bees from this colony were found on measurement to be slightly longer than any others in the yard. Whether or not this fact explained the greater prosperity of the colony, it continued for a period of three successive summers to store far more honey than any other in the apiary. The control of male parentage and the influence of the male parent upon the honey storing proclivities of the progeny may well receive some attention.

The cost of wax production to the bees has received some consideration from time to time. While it undoubtedly requires more honey under

some conditions to produce a pound of wax than is required under others, the results so far obtained have shown such a great variation as to be of little value. It would seem to be well worth while to undertake an exhaustive series of experiments under different conditions to secure further light on this point.

Conditions that control nectar secretion are, perhaps, just now, attracting more attention than any other. Too often the beekeeper looks forward to a bountiful harvest when he sees that an abundant bloom is assured, only to be disappointed. Last fall the Dadant bees were moved for a long distance to the fields of Spanish needle which bloomed profusely but yielded little nectar. At the Iowa station, some work along this line has been undertaken and two bulletins have been issued. However, very little is known on this problem which is of first importance to the beekeeper. The importance of the project certainly justifies intensive experiments in an effort to ascertain the particular factors which determine the flow of nectar. Enough is known to make it apparent that these vary with different plants.

In some sections, notably in the Appalachicola River region of Florida and the Uvalde region in Texas, there are times when there is a shortage of natural pollen. At such times the beekeeper finds it hard to build up his colonies in preparation for the honeyflow and sometimes even to keep them alive. Beekeepers generally have an impression that rye meal or similar substances will serve as a substitute for pollen. Those who should be in a position to know, however, state that these are of no value to the bees and may even be injurious. A careful study of this whole problem looking toward finding some way to enable the beekeeper to meet such conditions would be extremely valuable.

A very long list of problems might be outlined, but the fact is that we know very little about bees as yet, and one does not go far in any direction until he meets a question mark. Because so few trained men have become interested in the subject, our knowledge of equipment and management is far in advance of our knowledge of fundamentals. With more than thirty institutions taking an interest we may expect that many of these perplexities will be explained.

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Mr. C. O. Smith: I would like to ask if there has ever been any effort to ascertain the cost to the bee of ripening the honey?

Mr. Pellett: Not so far as I know.

Chairman Paddock: We will proceed with the next paper, which is the first number in the symposium on foul brood and is by Mr. S. B. Fracker.

# STOPPING THE DISTRIBUTION OF AMERICAN FOUL BROOD AT ITS SOURCE

By S. B. FRACKER, *Madison, Wis.*

The danger of the introduction of diseased material into clean territory has been well recognized in the case of all animal and plant diseases. For some reason it seems to have been given less attention in the case of bee diseases than of insect pests and live stock troubles. Thus far the only attempts which have been made, except in one or two states, to control the movement of apiary material which may be infected but is not known to be, are in the nature of inter-state quarantines. The failure of the latter, in the case of the distribution of bee diseases, is notorious, and is due almost entirely to the manner in which bees and bee supplies may be shipped and moved about freely inside of state limits without restriction. Unless employees of transportation companies develop the habit of looking for inspection certificates or permit tags of some kind in every case where bees are moved or shipped, they cannot be expected to be particularly careful when the movement is inter-state.

This matter has been brought with particular emphasis to the writer's mind recently by a couple of incidents. One was the story of a certain county in one of the Mississippi Valley states in which an area cleanup campaign had been attempted, based more on the cooperation of the beekeepers than legal authority in that particular state. Great progress was made in freeing the county from bee diseases in two years, but in the spring of the third year a large heavily infected apiary moved into the center of the county. For various reasons no further work was done in this area and the inspector who had been in charge of the area cleanup, states that the county is probably in as bad shape now as when the cleanup was begun.

The other incident related to the control of tuberculosis in live stock, in which the county cleanup method is also being attempted. According to one of the representatives of the U. S. Bureau of Animal Industry that Bureau is refusing to cooperate in the area cleanup of tuberculosis as long as the unrestricted movement of cattle to and fro across state and across county lines is continued. If the necessity for the regulation for the movement of material subject to infection is apparent in the case of bovine tuberculosis, it must be doubly so in the case of foul brood in apiaries, for tuberculosis is not, according to the veterinarians, distributed to any extent through the air, and does not spread from one herd to another in adjoining fields unless they are nosing along the same fence.

Under the area cleanup system of foulbrood control, as shown in papers published elsewhere, from thirty-three to sixty-six percent. of all the diseased apiaries in a county clean up completely the first season. Something over one-half of the others free their apiaries from the last traces of disease during the second season, and the few remaining require somewhat drastic action on the part of the inspectors during the third. In the meantime clean apiaries do not in our experience acquire infection in any appreciable numbers during an area cleanup campaign.

Practically every state apiary inspection law prohibits, as that of Wisconsin did for over twenty years, the movement of material which the beekeeper knows to be infected. Directly in the face of this provision, however, American foul brood has spread from state to state and county to county until the serious condition which is facing all the upper Mississippi Valley states has developed. With these regulations in force, 35 to 45 per cent. of the apiaries in Jefferson, Milwaukee, Manitowoc, Calumet, and Dane counties, Wisconsin, became infected with American foul brood. At the same time an even more serious situation developed in three or four counties northwest of Milwaukee, and along the Wisconsin river in Richland and Sauk counties. In parts of these areas beekeeping has been practically abandoned as a result of the losses from disease.

When the Wisconsin apiary inspection law was rewritten in 1919, the problem of controlling the transportation of diseased apiaries was very clearly in mind. It was not felt practicable to require an *inspection certificate* for the movement of all used apiary material and all bees in the state. The expense of sending inspectors to all parts of the state, in case bees are to be moved only short distances or from one point to another in heavily infected territory, would be disproportionately expensive. At the same time it seemed to be undesirable to attempt to handle the problem by means of regulations which would specify that bees could be moved either (a) less than six miles or (b) within the same county, or some provision of that kind because of the fact that such a regulation would be as impracticable to enforce as the old one.

The method finally agreed on by the members of the State Beekeepers' Association who interested themselves in this problem, and by the State Department of Agriculture, was that of requiring a permit from the state inspector in order to sell, give away, or move bees or used bees supplies under any circumstances. The apiary inspector was then given power to refuse to issue such permits whenever there seemed danger of the distribution of disease or until it was determined by inspection that the apiary or material was free from disease. This regulation applies to transportation companies as well as to beekeepers.

Application blanks were devised, making request for certain information in regard to the material to be moved. These were rather widely distributed throughout the state to officers of the county associations and to beekeepers who were likely to desire to move bees. When an application is received, either the permit is immediately granted and sent by return mail, or the application is referred to a local inspector who makes an examination of the apiary.

The regulation has now been in force for eighteen months. During 1920, 420 applications have been received, of which 26 came from beekeepers in southern states who desire to ship package bees to Wisconsin under the federal postal regulations, inspectors being lacking in their respective states. These were granted for the one season of 1920, but all states who engage in shipping bees, except Alabama, have now arranged for inspection for 1921. Of the remaining 394 which were from Wisconsin beekeepers, all were granted except six which were refused on account of the serious danger of the distribution of the disease, two withheld for some months pending treatment and re-inspection, and five withdrawn by the applicant.

These figures are particularly interesting from a practical standpoint, as of course no information could be secured in advance in regard to the magnitude of the problem of controlling local movements of apiary material. We now know that if the clerical and inspection staffs are organized in such a way that from 450 to 600 applications can be handled per year, about one-half of them coming in between March 15 and June 15, the problem can be handled satisfactorily.

In Wisconsin permits are granted immediately upon receipt of the application in the following cases: (a) Apiaries in clean or moderately clean territory which have been inspected and found free from disease within the past twelve months; (b) apiaries in heavily infected territory which have been inspected during the same season and found free from disease; (c) regardless of disease conditions, if the movement is to be less than three or four miles; (e) for the shipment of old comb to foundation factories in tight containers during December, January, February, and March.

Outside of these classes special inspections are made. The latter have been such a small porportion of the total, however, that the total cost of making special inspections has been about $234.60, while the total cost of handling the clerical work has been even less. The number of applications from apiaries which were inspected during the season, either as a result of special application or in the regular course of inspection, was 165.

The distance in many cases was small, about half the applications covering distances of less than five miles. If we omit the record of one apiary which was moved to California, another sent to Pennsylvania, and the shipments of comb to southern Illinois, the average distance was 32.4 miles per application. The average number of colonies to be moved was 18, and the average size of the apiary from which the material came was 52. These figures are surprisingly high when it is recalled that the average Wisconsin apiary contains 16 colonies but this is due to the large number of permits issued to commercial apiaries for the usual spring and fall transportation between outyards and the wintering location.

The support of the regulations on the part of the average beekeeper has been surprisingly encouraging. Occasionally delays, caused by the loss of applications or permits in the mails and similar incidents, have caused inconvenience, and in at least two cases beekeepers have suffered small financial sacrifices, owing to their desire to move material within twenty-four hours and the obvious impossibility of procuring a permit within that time. In one of these cases the apiary proved on subsequent inspection to be heavily infected, while in the other it was healthy.

Blanket permits covering more than one sale or movement have been given in only a very few cases. These are to beekeepers who make a business of supplying bees and equipment, as well as producing honey. This is not an extensive business in Wisconsin and it is understood that such permits for the sale of bees or queens will never be given except in annually inspected apiaries surrounded by large areas of clean territory.

The necessity of making special inspections has required the development of a special staff of local inspectors of whom 25 have already been appointed. The usual method is that the county beekeepers' association recommends three of its members, who then take a civil service examination in which the primary weight is given to experience and training. In most cases the department has been fortunate in securing men whose apiaries have been infected with American foul brood and who have successfully cleaned it up. Many of these county inspectors are employed only a day or two each season and five had no work at all during 1920.

We may conclude by answering one question which is always a matter of interest, namely what percentage of the actual sales or movements of bees does the department reach? In order to determine this point and assist in the administration of these provisions, a staff of about 200 volunteer correspondents has been developed who report all movements of apiary material of which they hear in their respective neighborhoods. During the season, out of 150 reports, it was found that all but 8 or 10

of the beekeepers who were reported selling or moving bees had permits. The remainder were warned and, in case any damage resulted to nearby beekeepers, prosecuted and fined.

After one season's administration of the control of bee disease by stopping such distribution at its source, namely, the infected apiary, the beekeepers show no desire to return to the former free movement of infected and uninfected material. On the contrary, there are many letters on file in the office indicating that beekeepers whose living depends on honey production feel safe for the first time. They believe that even if American foul brood territory is within a dozen miles, the regulation of the movements of bees will keep the disease from spreading and they hope that eventually the area cleanup method of control will eradicate it completely.

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CHAIRMAN PADDOCK: We will have all of the papers in the symposium before the discussion. The next is by Dr. M. C. Tanquary.

## LEGISLATION FOR CONTROL OF FOULBROOD

By M. C. TANQUARY, *State Entomologist; Chief, Division of Entomology, Agric. Exp. Station, College Station, Texas*

I do not know in just what way the program committee intended for me to discuss the question of legislation for control of foulbrood. But since we are all interested in the control, and if possible, the eradication of bee diseases in any way possible, I am assuming that the committee intended that I should discuss the part that legislation might play in bringing about the desired end, and to give in general some of the important points that should be embodied in legislation for this purpose.

I wish to say in the beginning, that the statements made in this paper refer only to American foulbrood. We have very little or no European foulbrood to contend with in Texas, and therefore I think it advisable to leave the discussion of any special legislation referring to European foulbrood to those states in which that disease is a menace. I believe, however, that the laws should be so worded (and in every instance I know of that is the case) that the person in charge of the work would have authority to deal with all bee diseases.

### RELATIVE MERITS OF EDUCATIONAL METHODS AND OF REGULATORY METHODS

Through correspondence and conversation with persons interested in this subject I have learned that there are in general two methods of

approach that are advocated for foulbrood control—the one being through education and the other through the adoption of legal measures for the control and eradication of disease. Some advocate chiefly the one and some chiefly the other. The very firm belief of the writer is that either measure without the help of the other will be a failure. The reasons for this belief are fundamental. Perhaps in a great many cases educational measures might be all that would be necessary. In other words, if all the beekeepers are made to understand the nature of bee diseases and to know the possibilities of these diseases as a menace to the beekeeping industry, they would be only too glad to take advantage of this knowledge and to use the proper methods for eliminating or reducing to a minimum all loss from such diseases. But because of certain elements which go to make up the sum total of human nature, there will always be a number of beekeepers or perhaps I should say people owning bees, who either through carelessness, indifference, or possibly through the possession of even more undesirable traits can be handled in no other way than by the arm of the law, and this number will always be large enough to prevent the eradication and complete control of bee diseases through educational methods alone. Even this perhaps comparatively small percentage, which refuses to be influenced by educational methods, is in actual practice reduced to a still smaller percentage by the knowledge that if they fail to be affected by the educational doses, a still stronger medicine may be administered in the form of legal compulsion.

As to the educational methods which may be used, I would say that every educational agency which can be brought to bear upon the problem should be employed, such as courses in beekeeping in Agricultural Colleges, state and county beekeepers associations, extension service, farmers' institutes, special schools in beekeeping, printed reports, circulars, bulletins, etc.; but in addition to all this, and I believe of even greater importance than all this, the men who go out to do the inspection work and control work generally, as authorized by the law, should be men thoroughly competent to do whatever educational work is necessary and should be men who would go out with the attitude of being friends and helpers of the beekeeper rather than with the attitude of one who goes out merely to do police control work. He should fall back upon the authority with which he is armed by law, only as a very last recourse, but in case it is necessary to attain the desired end he should use his authority to the fullest extent. The methods followed will naturally differ somewhat with the different people whom the inspector meets. It can be seen from the foregoing that the inspector should be not only a man competent to do the educational work, but he should be

a man who is actually interested in the welfare of the beekeepers. He should have abundant tact to get along with all sorts and conditions of men, and courage to face squarely unpleasant situations. I cannot emphasize too strongly the importance of the right qualifications in the men who are sent out as bee inspectors, because upon them will depend the success or failure of any method that is used.

## Organization for Foulbrood Control

A discussion of the qualifications of a bee inspector brings up the point of the entire organization for foulbrood control work. Here again I find, through a perusal of the foulbrood laws of most of the states that have such laws, that there are in general two methods, that of county organization and that of state organization. For example, in a number of states the county commissioners of a county may, upon request of a certain number of beekeepers within the county, appoint an inspector and deputies to inspect the bees in that county. In one state such inspector is supposed to inspect all colonies of bees in that county between May 1 and June 15 of each year and is to receive no compensation except such as may be contributed by interested persons. Such a condition of affairs of course reduces the matter of bee inspection and disease control to a farce. There are a number of reasons why county organization alone is unsatisfactory. For one, in probably at least nine cases out of ten the county commissioners would not be able to judge of the qualifications necessary in a bee inspector; for another, such an arrangement hopelessly ties up the matter of bee inspection with county politics, for another in many counties a man suitably qualified for the position would not be available, for another there would be no uniformity of procedure among the counties of the state, and for still another there would probably always be counties in which there would be no inspector appointed, but which would contain foulbrood and consequently always be a menace to the beekeeping industry in the rest of the state.

Taking into consideration the above statements, the conclusion is drawn that county organization is bound to be ineffective and unsatisfactory.

State organization is more desirable for the following reasons:

1. The work can be handled more uniformly, more effectively and more economically.

2. The work is put beyond the influence of local politics.

3. The position of inspector is made a much more important one and consequently men with better qualifications are attracted to it.

4. The work of the inspector can be more definitely correlated with educational work along beekeeping lines being done in the state.

5. The suggestions given by a state inspector are almost always given more consideration by the beekeeper than if they came from one of the beekeeper's neighbors.

6. There are often personal reasons why a local inspector would hesitate to take the steps which he would realize would be necessary in order to clean up foulbrood in his county. Such reasons would not be present in the case of the state inspector.

7. By means of a state organization a general program extending over a period of years could be mapped out, looking toward state wide eradication.

In some cases a combination of local inspectors working with the state organization may be used to advantage. In these cases the local inspector should serve especially one or more of the following purposes:

1. To act as a scout to detect first outbreaks of disease in his territory.

2. To make the necessary inspections in the event of bees being moved into or out of his territory.

3. To answer "Hurry up" calls for inspection in his locality in the event a state inspector is not available at the time.

Local inspectors for the above purposes are particularly useful in large states in order to save time and expense in travelling. I see no reasons for confining the work of a local inspector by county lines, or for that matter by lines of any kind within the state, excepting in a very general way. I do not believe that the local inspection should necessarily be given to any one man. The person who has charge of the state inspection work should have power to deputize any qualified beekeeper at any time to make any necessary inspection in his locality. By such an arrangement, some one would always be available in any part of the state for inspection work. The successful use of this plan would of course necessitate a wide acquaintance among the beekeepers of the state on the part of the person in charge of the work, but the nature of his work would naturally bring this about.

During the past year we have had in Texas an excellent opportunity to compare the results of the county inspection system with those obtained by sending inspectors out from the office. One man on the staff, Mr. C. S. Rude, gives all his time to foulbrood control work. In addition, this year we added to our force in June three young men who had taken one or more courses in beekeeping in the Texas A. & M. College and who had had excellent training for this kind of work. Two of these men were graduates of the college and the other ranked as a junior in college. These men were sent to those parts of the state where there was greatest need for inspection, regardless of whether there were county inspectors there or not. We were extremely fortunate in that Mr. Rude and the three assistants all possess to a very marked degree those quali-

ties which I mentioned above as being necessary in a bee inspector. The results could hardly have been more gratifying. Their work was thorough and they received the heartiest cooperation from the beekeepers themselves. When asked their opinion concerning the method, almost without exception the beekeepers endorsed the plan. Many of the county inspectors welcomed this plan, saying that they would much prefer putting in all their time on their own work. Many of these county inspectors are men with a big beekeeping business of their own, and they have done the work of county inspection more because of their interest in keeping foulbrood down in their locality than because of what they got out of it in the way of salary.

The following few instances may be given of the results of this year's work in Texas under the present plan. In one county a beekeeper a few years ago owned several hundred colonies. Foulbrood got into his yards and he finally had less than twenty colonies left. He had given up the idea of staying in the beekeeping business. One of our inspectors spent a little over two weeks in his county and had every case of foulbrood in his locality treated or destroyed. This man then declared that he had changed his plans entirely and intended now to go into beekeeping on a big scale. Another beekeeper who lives in a county which has had foulbrood for many years made the statement publicly that "In our county we might have said in the past that Inspectors come and Inspectors go but foulbrood stays on forever, but now for the first time we feel that we have foulbrood on the run." A spring inspection of his county revealed 200 cases of foulbrood. A thorough fall inspection revealed but three cases, two of which were destroyed and the other treated by the inspector. Just a few days before I left the office I received a letter from two of our state inspectors in the southern part of the state saying that they had discovered a foulbrood nest in that section. One man owning 93 colonies had 74 diseased, and there were also other cases of disease near him. This report came from a county which has a county inspector and which has been reported free from disease for several years past excepting for one case which appeared in the inspector's own apiary and which he destroyed. Many other similar instances could be mentioned, but I think those given are sufficient.

Many of the county inspectors are good beekeepers and good inspectors and have done most excellent work. The fact some of them have not been able to locate and eradicate all the foulbrood in their county or counties (some of them have more than one county) is not necessarily a reflection on their ability but is more a reflection on the system. The better beekeeper and inspector a man is, the greater his loss if he puts in his time inspecting other people's bees instead of taking care of his

own. One of our best inspectors was absolutely unable, because of the rush of his own work, to do any inspecting whatever this year at a time when another beekeeper in his county had to have 1864 colonies of bees inspected in order to move part of them out of the state temporarily.

With the idea of its leading perhaps to greater uniformity of foulbrood legislation in the various states where beekeeping is of importance, I am submitting a list of points which I feel should be considered in forming a model foulbrood law. These points are not given in legal phraseology, but are given in such a way as to be merely suggestive rather than complete. I have arrived at these conclusions through a perusal of the foulbrood laws of most of the States of the United States and through the experience of working with our own law in Texas. I will say that there are a number of state laws at the present time which embody most if not all of the points here given.

## Thirteen Points Offered as Suggestions in the Forming of a State Foulbrood Law

1. The organization for foulbrood control work should be a state organization and should be of such nature that local agencies or organizations could be utilized in case it is found desirable.

2. The entire organization should be as far as possible removed from state and local politics.

3. The work should be as closely as possible connected with educational and investigational work in beekeeping.

4. Provision should be made in the law whereby the person or group of persons having charge of the work might make whatever rules, ordinances or regulations are deemed necessary, and these rules, ordinances and regulations should have the full force and effect of law.

[I consider this one of the most important points of all. By means of this provision, new regulations may be made from time to time as the progress of the eradication should prove necessary or advisable. A number of the best state laws have such provision.]

5. Provision should be made for prohibiting the shipment into the state of anything capable of transmitting foulbrood.

6. Provision should be made for prohibiting the movement or shipment within or from the state of anything capable of transmitting foulbrood.

7. Inspectors should be authorized to enter any premises during reasonable hours for inspection purposes or for dealing with any article capable of transmitting foulbrood.

8. Queen bees and attendants should be shipped only from apiaries free from disease.

9. Violations of the law, or of the rules, ordinances and regulations made in accordance with the law, should be made subject to heavy penalty. Interferring in any way with the work of the inspectors should incur heavy penalty.

10. The person or persons having charge of the work should have ample authority to deal with all diseased material as he or they deem best under the circumstances. No compensation should be allowed for destruction of diseased material, or material which for any reason is a menace so far as bee disease is concerned.

11. Selling, giving away, bartering, owning, keeping, or exposing to other bees, any diseased material should be made unlawful.

12. The person or persons in charge of the work should have authority to require that all bees be kept in movable frame hives. In case of refusal to transfer, authority should be given to order the destruction without compensation to the owner of all colonies not kept in such hives.

13. Sufficient funds should be available to make the foulbrood eradication work effective throughout the state.

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CHAIRMAN PADDOCK: The next, by Mr. A. P. Sturtevant, will be read by Mr. Ernest R. Root of Medina.

## MIXED INFECTION IN THE BROOD DISEASES OF BEES

By ARNOLD P. STURTEVANT, *Specialist in the Bacteriology of Bee Diseases, Bureau of Entomology, United States Department of Agriculture*

The two principal brood diseases of bees, European foulbrood and American foulbrood, heretofore have not been found associated together commonly in the same colony. The generally accepted belief has been that it is indeed a rare occurrence to find both diseases under these conditions. Sacbrood, on the other hand, is much more often found in greater or less quantity associated with either European foulbrood or American foulbrood, but seldom assuming dangerous proportions, either alone or in conjunction with the others. Statistics for the past few years, however, show that these cases of what may be called mixed infection are probably more common than was previously supposed and may account for some of the puzzling instances where colonies have not responded to treatment in the customary manner, thereby causing beekeepers to believe they have some new form of brood disease, or that the disease is showing some new unheard of characteristics.

Cases of so-called mixed infections are not at all uncommon among human diseases. Where this condition occurs, such as when a person affected with typhoid fever develops pneumonia at the same time, it is always the individual to whom the term mixed infection is applied. It is a somewhat different matter in the case of the brood diseases of bees. In the first place, so far as is known, the organisms causing these two diseases, *Bacillus larvae* of American foulbrood and *Bacillus pluton* of European foulbrood, have never been found together in the same individual larva. It is, therefore, the colony as whole which is to

be considered as the individual unit, as is the case in the majority of the manipulations of beekeeping practice. This fact makes the problem slightly different from a case of mixed infection as considered from the point of view of human medicine. However, since different individuals are involved in the mixed infections there is no "a priori" reason for considering such cases as impossible.

The first published report of an authentic instance where both American and European foulbrood were found together in the same comb from a diseased colony was reported by McCray.[1] This report was concerning a sample (4982) received at the laboratory for diagnosis May 4, 1916, from Stanislaus County, California. Previous to this case only one other such sample (2598 from Brown County, Wisconsin in 1911) had been received for diagnosis, showing the presence of both diseases, but no report concerning it was published. These two samples were the only known authentic cases on record either in the Bee-Culture Laboratory among practically 5000 samples received up to 1916, or in the beekeeping literature. These two cases were considered to be interesting in that they demonstrated that the presence of both diseases at the same time in a colony was possible, but not much importance was given the matter because of their rare occurrence. White[2] states that "such a double infection has been encountered in the writer's experience very rarely. In such diagnoses, therefore, after European foulbrood had been found in the sample, American foulbrood is seldom looked for." This practice has been the custom generally as well when American foulbrood was found present in a sample, no further search for European foulbrood being made unless there were present strikingly prominent symptoms abnormal for American foulbrood. As a result the diagnostic records of the Office of Bee-Culture show but six cases of mixed infection up to December 31, 1918, among the approximately 6000 sample records.

Developments during the year 1919, however, showed that mixed or double infection is more probable than had been previously supposed. These facts were particularly impressed upon the writer during the spring of 1919 while on a trip investigating the bee disease conditions in the State of California. While in the field during a period of less than one month, and in three different counties of the State of California, six cases were found showing both American foulbrood and European foulbrood in the same colonies. Each case was diagnosed positively at once in the field by means of microscopic examination of dead larvae showing characteristic symptoms of the two diseases and found to contain the specific causative organisms. It is interesting to note that three

[1]McCray, A. H. 1916. Report of the finding of American Foulbrood and European foulbrood in the same comb. JOUR. OF ECO. ENT. Vol. IX, p. 379.

[2]White, G. F., 1920. European foulbrood. U. S. Dept. of Agric. Bul. 810.

of the six samples were found in Stanislaus County in the same locality as the sample reported by McCray in 1916. These cases were all found in regions where both diseases are exceedingly prevalent and of long standing. A few of the samples were fairly self evident from gross appearances, but the majority required a more minute examination.

From that time on, particularly after returning to the laboratory in Washington, more careful examination was made, both gross and microscopic of all samples received because of suspicions aroused by the unusual prevalence of the obvious cases found in California. This was done in order to eliminate the danger of overlooking cases where one disease might be predominant over the other, whether both diseases were suspected or not, causing the less prominent to be overlooked.

As a result, during the remainder of the year 1919 from June until December, twelve more such samples were received in the laboratory from various parts of the country, (18 in all for that year, total 24) all of which proved upon careful diagnosis to contain both American foulbrood and European foulbrood in the same sample of comb. Furthermore, during the year 1920, up until November 15th, fourteen more such samples were received, making a total in all of 38. Tables 1 and 2 give the data from sample records.

Table I.—Cases of Mixed Infection from Laboratory Records

| Date | Lab. No. | State | County | Apparent primary invader from gross appearance | Remarks |
|---|---|---|---|---|---|
| 9-20-11 | 2598 | Wisconsin | Brown | ? | Diagnosed by G. F. White |
| 5- 4-16 | 4982 | California | Stanislaus | American fb. | Diagnosed by A. H. McCray |
| 6- 3-16 | 5061 | California | Stanislaus | American fb. | Diagnosed by A. H. McCray |
| 5-16-17 | 5392 | Missouri | Jasper | Probably Afb. | |
| 5- 9-18 | 5836 | Mississippi | Washington | ? | Apparently about equal |
| 10- 9-18 | 6122 | Wisconsin | Barron | ? | More Efb than Afb |
| 4-19-19 | 6437 | California | Santa Barbara | Probably Efb. | One cell Afb. |
| 4-26-19 | 6441 | California | Sacramento | American fb. | From history of case |
| 4-26-19 | 6442 | California | Sacramento | American fb. | |
| 4-28-19 | 6445 | California | Stanislaus | European fb. | Few cells Afb. |
| 4-30-19 | 6449 | California | Stanislaus | American fb. | Few cells Efb. |
| 5- 1-19 | 6452 | California | Stanislaus | European fb. | From history of case |
| 5-20-19 | 6304 | Missouri | Lewis | ? | |
| 6-11-19 | 6401 | Ohio | Ashtabula | ? | |
| 6-27-19 | 6498 | Iowa | Johnson | American fb. | Efb early stages, also Sacbrood |
| 8- 1-19 | 6629 | Ohio | Trumbull | ? | |
| 8-15-19 | 6672 | Connecticut | Tolland | Probably Efb. | Afb slight amount |
| 8-25-19 | 6698 | Kansas | Cherokee | ? | |
| 8-29-19 | 6716 | New York | Cayuga | American fb. | Efb active Afb scales |
| 9- 2-19 | 6721 | Washington | Pacific | ? | |
| 9- 2-19 | 6722 | Washington | Pacific | ? | Efb more prominent |
| 9-19-19 | 6768 | California | Santa Barbara | ? | Afb 1st disease reported for county |
| 9-26-19 | 6778 | California | Santa Barbara | ? | |
| 10- 5-19 | 6834 | California | Santa Cruz | ? | |
| 5-12-20 | 6985 | California | Butte | European fb. | Afb one or two cells |
| 5-29-20 | 7023 | Michigan | Calhoun | ? | |
| 5-29-20 | 7025 | Michigan | Calhoun | ? | |
| 5-29-20 | 7026 | Wisconsin | Fond du Lac | European fb. | Few cells Afb |
| 6-17-20 | 7119 | Washington | Lewis | ? | |
| 6-17-20 | 7120 | Washington | Lewis | ? | Also Sacbrood |
| 6-22-20 | 7143 | New York | Allegany | European fb. | Few cells Afb. |
| 6-24-20 | 7158 | Pennsylvania | Crawford | ? | |
| 6-26-20 | 7172 | New York | Cayuga | ? | |
| 6-26-20 | 7174 | New York | Cayuga | ? | |
| 6-26-20 | 7177 | Pennsylvania | Crawford | ? | |
| 7-21-20 | 7335 | New York | Seneca | Probably Afb. | |
| 8- 5-20 | 7386 | Indiana | Blackford | ? | |
| 8- 5-20 | 7387 | Indiana | Blackford | ? | |

TABLE II.—SAMPLES OF MIXED INFECTION BY YEARS

| Year | Samples of mixed infection | Total Samples received |
|---|---|---|
| 1911 | 1 | 1042 |
| 1916 | 2 | 374 |
| 1917 | 1 | 449 |
| 1918 | 2 | 429 |
| 1919 | 18 | 693 |
| 1920 | 14 | 698 |
| 1905–1920 | 38 | 7568 |

This marked apparent increase in cases of mixed infection carries the subject over from one of scientific interest to one of practical importance. As is shown in Table III, the 38 samples of mixed infection have come from 24 counties in thirteen states, most of these located in prominent beekeeping regions. In eleven of these thirteen states both European foulbrood and American foulbrood as shown by samples of disease received in the laboratory for diagnosis are prevalent and of long standing. There are only about three or four other states where both diseases have been found in quantity from which samples of mixed infection have not been received, while only from two states of the many where the diseases are only occasionally bad have such samples been received.

TABLE III.—SAMPLES OF MIXED INFECTION BY STATES AND COUNTIES

| State | Counties | Samples |
|---|---|---|
| California | 5 | 12 |
| Connecticut | 1 | 1 |
| Indiana | 1 | 2 |
| Iowa | 1 | 1 |
| Kansas | 1 | 1 |
| Michigan | 1 | 2 |
| Mississippi | 1 | 1 |
| Missouri | 2 | 2 |
| New York | 3 | 5 |
| Ohio | 2 | 2 |
| Pennsylvania | 1 | 2 |
| Wisconsin | 2 | 3 |
| Washington | 2 | 4 |

Statistics obtained from the sample records, however, are not entirely conclusive since a majority of the samples come to the laboratory unsolicited. If a careful survey could be made of the regions where the brood diseases are bad and widespread, probably many more such cases would come to light.

TABLE IV.—DISTRIBUTION OF SAMPLES OF MIXED INFECTION BY MONTHS

| | |
|---|---|
| April | 5 |
| May | 9 |
| June | 10 |
| July | 1 |
| August | 6 |
| September | 5 |
| October | 1 |
| November | 1 |

These samples of mixed infection have been examined in eight out of the twelve months of the year, April to November inclusive, as shown in Table IV. Twenty-four of the total 38 samples, nearly 65 per cent., were examined during the months of April, May and June, the months during which European foulbrood is most prevalent.[3] In contrast to the spring months, eleven samples of mixed infection were examined during August and September, and only one each in July, October and November, a total of fourteen.

The question, however, of which diesase is most often the primary invader in a colony is difficult to answer, particularly without a history of the colony and locality. (Table I). If only dried adhesive American foulbrood scales are found, accompanied by numerous coiled fresh moist melting larvae of European foulbrood, it is not difficult to say that American foulbrood was the primary invader, perhaps during the previous season, as was the case of the sample reported by McCray. But often there is no such demarkation. Because the presence of American foulbrood depletes the strength of the colony this increases the probability of European foulbrood infection.

Since the requirements of the treatment of the two diseases are so entirely different, the necessity for correct diagnosis becomes of importance, particularly in regions where both diseases have been prevalent for some time. The presence of both diseases in the same colonies or even in the same apiary is a complicating factor in the diagnosis and treatment. Furthermore there is danger from the possibility of continued and confusing losses due to the ignorance of the presence of mixed infection in colonies under such circumstances and resulting therefrom, improper treatment which would only continue the losses.

Several samples have been received for diagnosis which beekeepers have thought contained both diseases and which indeed seemed to have some of the characteristics of each. Upon careful examination, however, both gross and microscopic, these have mostly proven to be definitely not mixed infections. The recognition of cases of mixed infection in

[3]Phillips, E. F., 1918. The control of European foulbrood. U. S. Dept. of Agric. Farmers' Bulletin 975, 16 pp.

colonies is often difficult because of the fact, as is particularly the case with European foulbrood, there are many irregularities and variations in symptoms that often add to the confusion of the beekeeper in making gross diagnosis hurriedly in the field. In order to more easily differentiate some of these confusing symptoms to assist in gross diagnosis, they may be divided into three classes. Occasionally in an unusually virulent case of American foulbrood or in one where the bees have deserted the brood because of its foul condition allowing what healthy brood there is to starve, larvae will be found which have died while still coiled in the cell, among the typical American foulbrood larvae.[4] These coiled larvae often have much the same appearance as typical European foulbrood coiled larvae. However, the consistency is generally quite different from European foulbrood, more like the typical slimy glue-like consistency of American foulbrood material. As a rule, however, the symptoms of American foulbrood are uniformly constant because of the fact that *Bacillus larvae* is almost always the only invader of the larvae causing death and a type of decomposition which prevents growth of other organisms. Several such cases were found in California.

A second class of confusing symptoms are found in samples which come particularly from regions where European foulbrood has been allowed to run unchecked for a long time. Such samples were found in certain sections of California and have been received from various other sections of the country. These samples show along with more or less of the typically coiled European foulbrood larvae, large numbers of larvae which have died after extending and even being sealed in the cell, showing a consistency somewhat like that of American foulbrood but more lumpy or like an old partly rotten rubber band.[5] Sometimes scales are found extended in the cells in such large numbers as to appear on casual examination like an old comb of American foulbrood. Close examination, however, shows the consistency, irregular shape and position with lack of adherence to the cell wall to be different from that in American foulbrood. This type was found to be quite prevalent in California.

The third class is composed of cases of actual mixed infection where typical American foulbrood, ropy larvae or scales, are associated in the same comb with typical European foulbrood, coiled moist melting larvae, or possibly occasionally the abnormal rubbery irregular larvae mentioned above. The active stage of the two diseases often seems to be localized more or less in different parts of the comb. This is probably due to

[4]White, G. F. 1920. American foulbrood. U. S. Dept. of Agric. Bul. No. 809.

[5]Sturtevant, A. P., 1920. A study of the behavior of colonies affected by European foulbrood of bees. U. S. Dept. of Agric. Bul. No. 804.

the fact that the queen would tend to desert that section of the comb containing the American foulbrood, particularly where this disease was the primary invader. In many cases one or the other of the diseases will be more prominent, at least in the active stages. This fact may be one of the causes for cases of mixed infection having been overlooked, the beekeeper seeing only the prominent outstanding symptoms. Therefore in cases where there is doubt or suspicion that both diseases may be present in the same colony, a positive laboratory diagnosis often appears to be desirable.

As is well known, the shaking method of treatment in its essentials is so far the only successful way of treating American foulbrood.[6] The nature of *Bacillus larvae* has prevented success along any other line, because of its ability to form exceedingly resistant spores and especially to decompose the dead larva in such a way as to cause the mass containing large numbers of these spores to adhere to the cell wall as if glued. It has been learned furthermore, often by sad experience, that the shaking treatment is practically never successful in the treatment of European foulbrood; in fact, often when used causes the disease to be spread all the more because of the weakening effect the shaking has on the colonies.[7] The requirements for the successful treatment of European foulbrood have been found to be fundamentally dependent upon adequately strengthening the colonies with young bees sufficiently to throw off the disease,[7] at the same time combined with the requeening of the diseased colonies with vigorous young Italian queens, permitting the bees themselves to remove the infected material.

The apparent logical solution of the problem of the treatment for a known case of mixed infection, therefore, is to combine the treatments for both American foulbrood and European foulbrood as a single treatment. In other words, the one or more colonies known or strongly suspected to have mixed infection should be shaken as for American foulbrood, requeening them with vigorous young Italian queens and later strengthening them by the addition of young bees or hatching brood from a healthy colony, or by uniting later. Strength of colony is the important factor combined with the shaking and requeening with vigorous Italian stock.

The problem of the control of mixed infections of American foulbrood and European foulbrood is primarily associated with the control of European foulbrood. In localities where both diseases are prevalent

[6]Phillips, E. F. 1920. The control of American foulbrood. U. S. Dept. of Agric., Farmers' Bulletin No. 1084.

[7]Phillips, E. F. 1918. The control of European foulbrood. U. S. Dept. of Agric., Farmers' Bulletin No. 975.

and there is suspicion of both being present in the same apiary, and possibly even some as mixed infection in the same colony, control of the two diseases will depend upon the elimination of European foulbrood first. This should be done by treating the entire apiary for European foulbrood, by strengthening and requeening all the colonies with young and vigorous Italian queens, which is after all only good beekeeping. After the elimination of European foulbrood it will be a simple matter to determine those colonies that have not responded to this treatment, as being American foulbrood. This method is possible because of the fact that American foulbrood seldom spreads with the rapidity of European foulbrood, particularly if care is taken to prevent robbing and mixing up of combs. Those colonies which continue to show American foulbrood remaining may now be given the usual shaking treatment.

Chairman Paddock: The next part of the symposium is "The Future of Bee Disease Control" by E. F. Phillips of Washington, D. C. Inasmuch as Dr. Phillips is not present, but has sent his paper it will be published with those read by title.

Chairman Paddock: The next paper is by Professor H. F. Wilson.

Mr. Wilson: The title of the paper should be "Spread and Control of American Foul Brood."

The spread and control of American foul brood is of evident importance as shown by the space it has taken in our bee journals. The problem is one that is not as serious as we have believed. The difficulty has been that not only the bee keepers but the investigators themselves did not thoroughly understand the spread and control of the disease, and only during the last two or three years has there been sufficient light on the subject to permit of a proper method of preventing the spread and securing the eradication of the disease.

## SPREAD AND CONTROL OF AMERICAN FOUL BROOD

By H. F. Wilson, *Madison, Wisconsin*

(Withdrawn for publication elsewhere)

Mr. Wilson: I might say that in Wisconsin there has been a great deal of discussion among the bee keepers as to whether or not they could use the old brood comb from diseased colonies, and this has been one of the means of carrying diseases on indefinitely.

The main point is that the bee keeper has not known and does not know what to do, and it is necessary for us to carry on our campaign of education in connection with the law in order to let the bee keeper know what he has to do.

CHAIRMAN PADDOCK: The importance of this subject commands careful consideration by this body and I hope you that will feel free to discuss this matter fully. I am sure that there are some here who have views that they might care to express.

MR. ROOT: There is one point that I can illustrate on the board of distinction between the two diseases. I think of all the states I have ever been in, in the United States, California has been diseased the worst. I do not think there is any possibliity of being mistaken on that point. They had one kind of Foul Brood that is very confusing there. It is a European Foul Brood in advanced stage. It looks so much like American that it is called American and they treated it for American but it did no good. We used to say that if any dead matter will rope out an inch or two inches, you can tell whether it is American or European. If it ropes out an inch or so, it is American. That rule does not apply.

CHAIRMAN PADDOCK: If there is no further discussion, we will proceed to the transaction of the business and under that heading I will ask Dr. S. B. Fracker to bring a matter to your attention.

DR. S. B. FRACKER: At the request of Mr. Kindig, the State Inspector and Apiarist of Michigan, the Apiary inspectors of the Mississippi Valley met at Chicago on December 6, 1920, discussing various facts of interest to bee keepers. Resolutions were passed on one topic. They were really in the form of an agreement between the inspectors.

Since coming to the meeting, the Chairman of this section and the Secretary have asked me to present an outline of the action taken and the reason therefor. The meeting was called primarily because of the transportation from one state to another in this territory of two apiaries into clean territory under an inspection certificate from the State of origin. The transportation naturally resulted in a certain amount of correspondence and apologies from the inspectors who personally examined the apiaries. In heavily infected territories, two or three colonies were found diseased and destroyed, the remainder of the apiary was given a certificate of inspection and freedom from diseases. The apiary was transported into another state into clean territory and the diseases were introduced. In one case, at least, the territory had been cleaned at great expense through an apiary cleanup campaign, and not a single case was known in the territory at that time, although they had had diseases before.

The result was that the following agreement was reached:

RESOLVED, That the undersigned apiary inspectors of the North Central States and Canada believe and agree that inspection certificates for the inter-state transportation of bees and used apiary supplies should be given only to apiaries which have never been infected or which have been free from American Foul Brood for at least one year.

Provided, however, that bees newly shaken on foundation under the supervision of an inspector, or bees in combless packages supplied with food made from pure sugar only are exempted from the provisions of this section.

It is further agreed that whenever a case of the inter-state transportation of bees or used bee supplies with or without an inspection certificate comes to the attention of one of the undersigned, full information will be sent to the state inspector of the state of destination.

The inspectors meeting together were:

B. K. Kindig, R. H. Kelty, P. T., Ullman, East Lansing, Michigan; S. B. Fracker, H. L. McMurry, State Capitol, Madison, Wis.; C. D. Blaker, Minneapolis, Minn.; F. B. Paddock, Ames, Iowa; A. L. Kildow, Putnam, Ill.; F. N. Wallace, C. O. Yost, Indianapolis, Ind.; E. C. Cotton, Columbus, Ohio; C. L. Hershiser, Kenmore, New York; F. Eric Millen, Guelph, Canada.

The following also met with the inspectors:

J. C. Henager, Salt Lake City, Utah, representing the state apiary inspector of Utah; H. B. Parks, San Antonio, Texas; B. J. Kleinhesselik of Hardin, Montana; and E. Ewell, Ypsilanti, Michigan.

It was suggested at that time that the matter be brought to the attention of this body. I believe, however, that the section has no Committee on Resolutions. As this represents a body covering the entire United States, it may be that the resolutions as they are worded are not entirely applicable to or do not represent the sense of this body. However, one question which was taken up at that time and which can be brought before this body is that of stricter regulation on inter-state transportation of bees and used bee supplies. At present the only regulations there are apply to postal shipments. There are no inter-state regulations applying to freight or express, and the postal regulations are that packages of bees or used bee supplies shall have attached to them either an inspection certificate or sworn statement that the honey used in preparing the food in the case of combless packages was boiled half an hour, I believe it is.

It has recently come to our attention that this statement from the shipper is practically of no value owing to the habit of a large number of southern bee keepers using these certificates carelessly, and we have very good information indicating that it is not the practice to boil the honey at all in spite of the fact that this certificate is attached.

The second form of information that is in our hands is the secondary use of these statements. There is no requirement of the signer of the

certificate to the effect that the honey has been boiled by the shipper, consequently large numbers of these printed tags have been sent to certain apiaries and they have been carelessly attached to any shipment that it was convenient to make.

Is a motion in the form of a resolution along these lines in order?

CHAIRMAN PADDOCK: There is a general Resolutions Committee of the Association. I would like to know the pleasure of this body concerning this matter. You have heard the resolution and the information from the gathering on the 6th of December. Some of these parties are here tonight. What is the pleasure of this Section relative to this matter?

MR. BALL: I move you that the Chair appoint a Committee of three to take this up and prepare a general resolution to embody the idea, with the part in regard to the permission to ship bees that have been infected with American Foul Brood eliminated, and that we adopt that now, giving the Committee power to reconstruct it so as to be acceptable with that provision eliminated.

D. Ball's motion was seconded and carried.

CHAIRMAN PADDOCK: I will appoint on that Committee Dr. Ball, Mr. Cotton and Dr. Fracker. It is the understanding that the action of that Committee will bind this Section.

CHAIRMAN PADDOCK: Is there any other matter to be brought before this Section in its business session?

MR FRACKER: Would it be in order to move that the matter of making recommendations on legislation for Federal regulation of inter-state transportation of bees be also referred to this same Committee?

CHAIRMAN PADDOCK: I think it should, with power to act. If there are no further items of business, we will hear the report of the Nominating Committee.

MR. F. C. PELLETT: Mr. Chairman, your Committee begs leave to recommend for Chairman for the coming year, Prof. H. F. Wilson of Wisconsin; for Secretary, our present incumbent, Prof. G. M. Bentley.

CHAIRMAN PADDOCK: What is your pleasure in regard to the report of the Nominating Committee?

MR. PELLETT: I move the adoption of the report.

The motion was seconded and carried unanimously.

Adjournment.

## EXPERIMENTS WITH GRASSHOPPER BAITS[1]

By J. R. PARKER and H. L. SEAMANS, *Bozeman, Mont.*

During the summer of 1919 preliminary experiments were conducted for the purpose of improving the efficiency and reducing the cost of the poison bran mash commonly used for grasshoppers, special attention being given to finding substitutes for the lemons and oranges generally recommended to make the mash attractive. While the tests were not extensive enough to warrant the drawing of any general conclusions, certain materials appeared so promising that a report is given at this time in the hope that other workers will try them out during the present season.[2]

### MATERIALS TRIED AS SUBSTITUTES FOR CITRUS FRUITS

The following materials were used in place of oranges or lemons in the standard formula: amyl acetate, vanilla extract, lemon extract, vinegar, watermelon, cantaloupe, banana, and ground apples. As checks in all experiments, the poison bran mash was tried with salt and molasses only, and with salt alone. Equivalents were used on the basis of one lemon being equivalent to any one of the following amounts:

1. 2 teaspoonsful of 4 per cent. lemon extract
2. 2 teaspoonsful of vanilla extract
3. 2 teaspoonsful of vinegar
4. 1 teaspoonful of amyl acetate
5. 1 orange
6. 1 apple
7. 100 grams banana
8. 100 grams cantaloupe
9. 100 grams watermelon

The various baits were prepared according to the following formula:

| | |
|---|---|
| Bran | 25 lbs. |
| Paris green | 1 lb. |
| Salt | 1 lb. |
| Molasses | 2 qts |
| Lemon or equivalents | 12 units |
| Water | 10 quarts |

[1]Contributed from the Entomological Laboratories of the Montana State College.

[2]Since this paper was submitted for publication in April, 1920, we have had an excellent chance to try out amyl acetate on a large scale, 12,300 ounces having been used during the summer of 1920 in a severe grasshopper outbreak. County Agents and farmers having once tried the amyl acetate flavored poisoned bran mash would use nothing else. It was very effective and the campaign was the most successful we have ever conducted. The use of amyl acetate as a substitute for lemons in this one campaign saved at least $2,000 in the cost of materials, reduced the labor necessary in mixing the poisoned bran mash, and increased its effectiveness.

Since the experiments were conducted primarily to determine the relative value of the various flavoring materials, they were used at the strength recommended for immature grasshoppers, i. e., twice as strong as when used against adults. This was done so that each kind of bait would have a strong distinctive odor of its own.

## Method of Putting Out Baits

In the first experiments the various baits were scattered on boards and over small plats in areas 30 yards apart where grasshoppers appeared to be uniformly distributed. The number of grasshoppers feeding at each board was recorded every twenty minutes and counts of dead grasshoppers were made on the plots at the end of two days. This method did not prove satisfactory as it was observed that the grasshoppers moved about during the day and that their distribution was by no means uniform or constant. In other words, the scarcity or abundance of grasshoppers in the vicinity of any particular bait had a much greater bearing on the results than did the relative attractiveness of the bait itself.

Where observations are made every twenty minutes there is too great an element of chance for satisfactory results. At the particular moment the observation is taken the grasshoppers may have momentarily ceased feeding because of a passing cloud or gust of wind, while a few minutes before they may have been feeding very heavily. The results of the first experiments were so variable that they were not reported. However, it should be stated that in practically every test amyl acetate was far ahead of all the others that were tried.

In order to overcome the question of uneven distribution and the element of chance in making observations, it was decided to conduct all tests at one point and have them under continuous observation. Each kind of poison bran mash was placed in a small tin pan six inches in diameter and one inch deep. The pans were arranged in a three foot circle where adults of *Camnula pellucida* Scudd. had gathered in large numbers for breeding, and egg laying. An observer stationed ten feet from the pans watched with field glass and recorded every grasshopper that climbed into a pan and actually fed. The relative position of the pans in the circle was changed and fresh bait was put out every two hours. All of the experiments reported on were conducted in this way.

## Results of Experiments

Experiments were conducted on August 4, 6, and 7, during which time 2074 grasshoppers climbed into the pans and registered their choice.

Table I.—Showing the Number of Grasshoppers Feeding Daily at Variously Flavored Poisoned Baits

| Attractive Element | August 4 | | August 6 | | August 7 | | Total Number Feeding | Final Rank |
|---|---|---|---|---|---|---|---|---|
| | Rank | Number Feeding | Rank | Number Feeding | Rank | Number Feeding | | |
| Amyl acetate | 1 | 49 | 1 | 166 | 1 | 164 | 379 | 1 |
| Vanilla | 8 | 10 | 2 | 127 | 2 | 105 | 242 | 2 |
| Watermelon | 2 | 33 | 3 | 96 | 11 | 47 | 174 | 3 |
| Molasses and salt only | 9 | 8 | 4 | 78 | 6 | 69 | 157 | 4 |
| Salt only | 10 | 7 | 5 | 76 | 5 | 74 | 157 | 4 |
| Oranges | 3 | 18 | 6 | 75 | 9 | 59 | 152 | 5 |
| Apples | 7 | 11 | 8 | 72 | 7 | 69 | 152 | 5 |
| Cantaloupe | 4 | 18 | 11 | 50 | 4 | 78 | 146 | 6 |
| Vinegar | 6 | 13 | 9 | 61 | 3 | 79 | 143 | 7 |
| Bananas | 5 | 18 | 10 | 55 | 10 | 57 | 135 | 8 |
| Lemons | 11 | 7 | 7 | 75 | 12 | 44 | 126 | 9 |
| Lemon extract | 12 | 6 | 12 | 42 | 8 | 63 | 111 | 10 |

## Conclusions

1. Amyl acetate was decidedly the best of all the attractive materials used, ranking first in every test and attracting far more grasshoppers than any other bait. The use of amyl acetate in grasshopper baits was first suggested by Professor R. A. Cooley in 1918 and was tried in one experiment with promising results during that season. Our results with it in tests conducted this year lead us to believe that it is a most promising substitute for citrus fruits in the standard poison bran mash bait for grasshoppers. Amyl acetate is not only the most attractive of the materials tried out but is also the cheapest of those that ranked high in attractiveness. An ounce costs five cents and is equal to eight lemons or oranges. It also has the additional advantage of being ready to add to the poison bran mash without cutting or grinding, it is so concentrated that it is easy to transport, and it will keep indefinitely.

2. Vanilla ranked second in the list of attractive materials and with amyl acetate was far better than any of the other materials tried. Its present cost is such that it cannot be used economically in grasshopper baits.

3. Of the fresh fruits used, watermelon gave the best results but it was no where near as attractive as amyl acetate or vanilla and was little better than salt alone.

4. One of the surprising results of the experiments was that salt alone gave just as good results as when molasses and salt were used and that both gave better results than when lemons or oranges were added. This is of considerable interest because it indicates that excellent results may be obtained even when it is impossible to secure molasses or citrus fruits, as sometimes happens. If this point can be established by further experiments, it means that thousands of dollars have been wasted in the useless purchase of molasses and citrus fruits. It will also mean that in the future farmers will more readily use grasshopper baits because of decreased cost and labor in the preparation. It should

be noted here that Morrill[1] and Ricker[2] have shown that molasses is not necessary against cutworms and several species of grasshoppers.

5. It was found that lemons, which have been widely recommended as the attractive element in grasshopper baits, were the least attractive of all the materials tried with the exception of lemon extract. Oranges gave better results than lemons, ranking fifth, while lemons ranked tenth.

6. It should be borne in mind that the tests were concerned with adults of only one species of grasshoppers, *Camnula pellucida* Scudd., which had gathered in great numbers for breeding and egg laying. The writers wish it distinctly understood that they consider the experiments too limited and the conditions too abnormal for the drawing of definite conclusions or to warrant the radical changing of methods in preparing grasshopper baits. The results of the tests are given merely to suggest materials that may in the future prove more effective and cheaper than those now in use.

## Scientific Notes

**Imported Pine Sawfly.** Larvae of *Diprion simile* were collected at Harrisburg, Pa., on September 13, 1920, by F. M. Trimble and T. L. Guyton, Assistant Entomologists with this Bureau. Adults were reared and identification verified by Mr. S. A. Rohwer. This, I believe, is a western record for Pennsylvania.

J. G. SANDERS

**Salt Marsh Mosquitoes Far Inland.** In the course of the mosquito survey of southern Illinois conducted by the Illinois Natural History Survey, two salt marsh species have been discovered. *Anopheles crucians* Wied. was reared from a pond at Herrin in September 1920, and *Aedes sollicitans* (Walker) D & K was taken once at Carbondale in March 1918, and several times in considerable numbers in May 1920 at Herrin. Identifications of these species were kindly confirmed by Dr. Dyar.

Although apparently far from their natural habitat, it is possible that they are living under conditions approximating the sea coast, since this section is underlaid with salt, as witnessed by the occasional salt springs and salt outcroppings.

S. C. CHANDLER
*Field Entomologist for Southern Illinois*

**The Thuberia or Wild Cotton Boll Weevil.** (*Anthonomus grandis* var. *thurberiae* Pierce) has made its appearance in cotton fields near Tucson, Arizona. In 1914, this insect was found by Mr. B. R. Coad of the U. S. Bureau of Entomology, infesting experimental plots of cultivated cotton in the foothills in a location recognized as especially favorable for such infestation to occur but the insect has not previous to 1920 been found attacking commercial plantings. Although not unexpected to those acquainted with the wild cotton situation in Arizona, and the abnormal conditions which have existed during the past season, the actual discovery of the weevil in Arizona cotton fields marks a notable event in the history of cotton culture in the arid Southwest. A. W. MORRILL

[1] JOUR. ECON. ENT., Vol. 12, No. 4, p. 337.
[2] JOUR. ECON. ENT., Vol. 12, No. 2, p. 194.

# JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1921

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The second annual dinner, like the first, was a most pleasant and popular affair, a very desirable change from the more serious regular sessions. The editor is but voicing a general sentiment when he congratulates the originator upon his happy thought and compliments him and his associates upon the admirable manner in which it was executed.

The Thirty-third Annual Meeting has passed and proved to be a well attended and highly successful gathering. The broader entomological problems received considerable attention as well as many of the more restricted and special interests. The joint session with the Plant Pathologists on dusting made possible an admirably broad summation of the questions involved by representatives of both organizations from different parts of the country. The comparatively innocent appearing title: "The Spreading of Sprays" opened a vista into closely related problems having a most practical bearing on economic entomology. It was typical of a number of cases where entomologists need close and long sustained co-operation from investigators along other lines if the best results are to be obtained without great delay. The difficulty of securing team work of this character was an important factor in the organization of the Crop Protection Institute, an organization which has among its possibilities a profound modification of the investigational work of the country.

The great delay in mailing the December issue was unanticipated and due to a very unusual combination of circumstances. The editor was in hopes the issue would be in the hands of most members a week before it was necessary to leave for the annual meeting. Particular attention is called to the editorial of that number because it summarizes present conditions and outlines the policy recently adopted.

# Current Notes

### Conducted by Associate Editor

The Illinois State Beekeepers Association held its annual meeting at the Leland Hotel, Springfield, on December 14 and 15.

The Tennessee State Beekeepers Association held its annual convention at Nashville, Tennessee, on January 27, 1921.

Dr. J. M. Aldrich was elected president of the Entomological Society of America at the Chicago meeting.

The annual meeting of the Minnesota State Beekeepers Association was held at Minneapolis on December 7 and 8.

Mr. H. P. K. Agersborg has been appointed assistant in zoology and parasitology at the University of Wyoming.

Doctor S. B. Fracker, acting State Entomologist of Wisconsin, was appointed State Entomologist, to take effect July 1, 1920.

Mr. R. D. Olmstead, assistant in entomology at the New York (Geneva) Agricultural Experiment Station, resigned October 1st, 1920.

The Thirty-second annual meeting of the California State Beekeepers Association will be held at Oakland, March 1–4, 1921.

Professor W. C. O'Kane is chairman of the Crop Protection Institute organized recently under the auspices of the National Research Council.

The annual meeting of the Chicago-Northwestern Beekeepers Association was held in the Great Northern Hotel, Chicago, December 6 and 7.

Mr. J. C. Holton, formerly with the State Plant Board of Florida, is now in charge of the sweet potato inspection service in Mississippi.

Mr. George F. Arnold has resigned his position with the Federal Horticultural Board to accept a position as assistant entomologist with the State Plant Board of Mississippi.

Doctor T. J. Headlee gave an address on Mosquito Control at a luncheon of the Chamber of Commerce at Hotel Taft, New Haven, Connecticut, December 18, 1920.

Mr. J. G. Hester has resigned his position with the Federal Horticultural Board to accept a position as assistant entomologist with the State Plant Board of Mississippi.

Announcement was made of a joint meeting of the Washington State Beekeepers Association and the Inland Empire Beekeepers Association, held at Spokane, Washington, December 14, 15 and 16.

Mr. H. L. Dozier spent the past year in the Graduate School of Ohio State University, and is now assistant entomologist for the State Plant Board of Mississippi.

Doctor F. C. Craighead of the Bureau of Entomology, Washington, D. C., has been appointed entomologist in the Division of Forest Insects, Entomological Branch, Canadain Department of Agriculture.

Mr. E. W. Stafford, Assistant Professor of Zoology and Entomology in the Mississippi A. & M. College, was in the Graduate School of Cornell University, during the past summer.

Doctor A. E. Cameron, Saskatoon, Saskatchewan, and A. B. Baird, Fredericton, N. B., have been granted a six months leave of absence from the Entomological Branch, Canadian Department of Agriculture.

Miss Gladys Hoke is continuing her work on scale insects in Mississippi. She spent several months early in the year studying with Doctor A. D. MacGillivray at the University of Illinois.

The annual meeting of the Pennsylvania Beekeepers Association was held at Harrisburg, January 26, during Farmers' Week. Doctor E. F. Phillips was on the program as one of the speakers.

Mr. Eli K. Bynum, formerly with the State Plant Board of Florida, is now located at Ocean Springs, Mississippi, where he is employed as an inspector for the State Plant Board of Mississippi.

Prof. H. Okamoto, formerly of the department of entomology of the Hokkaido Agricultural Experiment Station, Sapporo, Japan, is now entomologist of the agricultural experiment station at Suigen, Corea.

Prof. Saturo Kuwayama has been appointed entomologist of the Hokkaido agricultural experiment station, Sapporo, Japan.

According to *Science*, Professor Clarence E. Mickel, Extension Entomologist, College of Agriculture, University of Nebraska, has resigned to accept a position as research entomologist with the American Beet Sugar Company, Rocky Ford, Colorado.

Mr. F. M. Hull has returned to continue his studies at the Mississippi A. & M. College. He was employed during the past summer at the Japanese Beetle Laboratory at Riverton, New Jersey.

Mr. P. R. Myers of the Bureau of Entomology, has been placed in charge of the field laboratory at Carlisle, Pa., to fill the vacancy caused by the death of Mr. W. R. McConnell.

The New Jersey Beekeepers Association held its annual meeting at Trenton on January 13 and 14, 1921. The program was arranged by the Secretary, E. G. Carr, New Egypt, N. J.

Doctor M. W. Blackman has returned to take up his work as Professor of Forest Entomology at Syracuse University, after spending eight months in Mississippi, studying forest insects for the State Plant Board of Mississippi.

Resignations from the State Plant Board and Entomological staff in Mississippi since July 1, 1920, have been as follows: R. L. Howell, W. H. Carpenter, E. G. Wade, J. F. Scoggin and B. L. Collins.

A three days annual meeting of the Michigan Beekeepers Association has been planned for January 25, 26 and 27 at East Lansing, probably at the Agricultural College. Mr. R. H. Kelly, East Lansing, is the secretary.

Imperial Bureau of Entomology. The publication office is now at 41, Queen's Gate, London, S. W. 7. Send all communications respecting subscriptions or exchanges for the Review of Applied Entomology and the Bulletin of Entomological Research or to the Bureau Library, to the Assistant Director at the above address.

The Florida State Beekeepers Association was organized at Gainesville, October 6, about 65 being present. The following officers were elected: J. W. Barney, presi-

dent; J. K. Isabel, vice-president; J. R. Hunter, secretary, and K. E. Bragdon, treasurer.

According to *Gleanings in Bee Culture*, Mr. H. B. Parks resigned as State Apiarist of Texas on November 1, to take up his new work in the sales promotion and extension department of the Texas Honey Producers Association.

Resignations from the Entomological Branch, Canadian Department of Agriculture, are announced as follows: G. M. McFarlane, Saskatoon Laboratory; E. P. Donat, Annapolis Laboratory; G. H. Hammond, Division of Field Crop and Garden Insects; Miss M. M. Nash, stenographer, headquarters.

The following resignations from the Bureau of Entomology have been announced: Joseph N. Crister and J. C. Woolley, Southern field crop investigations; George S. Demuth and E. Watkins, Apicultural Investigations; C. A. Bennett, Tropical and Subtropical Fruit Insect Investigations.

It has been announced that the Ohio State University gave a short course for beekeepers January 31 to February 5. Doctor E. F. Phillips of Washington, D. C., was in charge. Mr. George S. Demuth was also one of the speakers.

Mr. W. R. Thompson of the Bureau of Entomology who is now in southern Europe collecting insect parasites of the European corn borer, reports encouraging progress. Several hundred Hymenopterous parasites have already been shipped to Boston and arrived in excellent condition.

Professor J. G. Sanders, Director of the Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pa., is the official entomologist of a scientific expedition sent by the Everhart Museum, Scranton, Pa., to Panama. He plans to spend two months in the field.

The Chancellor's 28th biennial report of the University of Kansas shows the growth of the entomological department of that institution. In 1915–16 there were three instructors and 153 students; at present there are 337 students, though the number of instructors remains the same. In the same period the number of student hours has increased from 475 to 1405, an increase of 196 per cent.

Mr. R. N. Lobdell, Associate Professor of Zoology and Entomology at the Mississippi A. & M. College, addressed, by invitation, the Southern Nurserymen's Association at Charleston, South Carolina, on August 19, 1920, and the Tennessee Florists' Association at Memphis, Tennessee, on November 17, 1920.

Mr. F. H. Benjamin, Assistant Entomologist for the State Plant Board of Mississippi, has returned to Ithaca, New York, to continue his studies in the Graduate School of Cornell University, and is planning to return to Mississippi in February. He is devoting his entire time to Lepidoptera.

Mr. H. A. Scullen, formerly special field agent in beekeeping extension work for the State of Washington, has recently been appointed in charge of bee culture work at the Oregon Agricultural College at Corvallis, Oregon, and will have charge of the class work as well as extension work in Oregon.

Mr. J. L. King of the Pennsylvania Bureau of Plant Industry has been appointed specialist in insect parasites in the Federal Bureau of Entomology and has been sent to Japan to assist Mr. C. P. Clausen in collecting and rearing parasites of the Japanese beetle for introduction into New Jersey.

Mr. A. C. Burrill, special field agent of the Bureau of Entomology, who has been engaged in North Dakota, where for three years he has conducted the most extensive grasshopper campaign that this country has ever seen, has resigned to accept the position of Extension Entomologist at the University of Missouri, Columbia, Mo.

Mr. H. W. Allen, formerly with the U. S. Bureau of Entomology, came to Mississippi last June to accept a position as Assistant Entomologist with the State Plant Board. He has recently been transferred to the Entomology Department of the Mississippi A. & M. College, and is now devoting the greater part of his time to teaching.

A report of the proceedings of the meeting of the Association of Cotton States Entomologists held at Vicksburg, Miss., and Tallulah, La., March 1-3, 1920 (see this JOURNAL, Vol. 13, pages 256, April 1920) has been prepared in mimeograph form, and may be obtained by sending one dollar ($1.00) to A. F. Conradi, Secretary, Clemson College, S. C.

Mr. Oliver I. Snapp, for the past three years representing the Division of Deciduous Fruit Insects of the U. S. Bureau of Entomology in extension and investigation work in Mississippi with headquarters at Agricultural College, Mississippi, has been transferred to Fort Valley, Georgia, where he is in charge of the Bureau of Entomology Laboratory. His work will be almost entirely on peach insects.

Mr. P. H. Rolfs has severed his connection as director of the extension work in Florida on the 31st of December. After the first of January 1921 his address will be Bello Horizonte, Estado Minas Geraes, Brazil, where he is commissioned to locate, establish and conduct an agricultural institution of research and instruction. The President of Minas Geraes desires that the heads of departments shall be American scientists.

Mr. L. S. McLaine of the Entomological Branch, Canadian Department of Agriculture, spent two weeks in October in company with Mr. H. L. McIntyre of the Federal Bureau of Entomology, in northern New Hampshire, Vermont and the Maritime Provinces, examining the territory liable to soon become infested with the gipsy moth which is now in Maine and New Hampshire, only about twenty-five miles from the Canadian border.

A second conference in regard to the Mexican Bean Beetle was held at Birmingham, Alabama, on October 19, 1920. Among those in attendance were Doctor C. L. Marlatt, Chairman, and Doctor K. F. Kellerman of the Federal Horticultural Board; Professor Wilmon Newell of Florida; A. C. Lewis of Georgia; R. W. Harned of Mississippi; C. H. Popenoe and J. E. Graf of the U. S. Bureau of Entomology.

The annual meetings of the Ontario Entomological Society were held at Guelph November 17 and 18, with Mr. Arthur Gibson, President, in the chair. The following entomologists were present from the United States: Doctor E. P. Felt, State Entomologist, Albany, N. Y.; Professor C. R. Crosby, Cornell University, Ithaca, N. Y.; Mr. W. R. Walton, Washington, D. C., and Mr. L. H. Worthley, Boston, Mass., of the Federal Bureau of Entomology.

According to the *Experiment Station Record*, the division of entomology of the University of California has been reorganized as the division of entomology and parasitology. Professor W. B. Herms has been appointed head of the division, continuing his activities in parasitology, practical medical entomology, and ecology. The division is made up of three groups, viz. general entomology and taxonomy, agri-

cultural entomology, and parasitology, in relation to animal industries, in charge respectively, of E. C. Van Dyke, E. O. Essig, and S. B. Freeborn.

Mr. Frank Pellett of Hamilton, Illinois, and Professor H. F. Wilson of the University of Wisconsin, spent a week from August 30th to September 4th, 1920, in Mississippi, where they addressed enthusiastic meetings of beekeepers at Greenville, on August 31st, Agricultural College on September 2d, and Gulfport on September 4th. They were investigating beekeeping conditions in Mississippi. These meetings had been arranged by Specialists in Bee Culture, R. B. Wilson, and Entomologist, R. W. Harned.

On September 7th and 8th, a collecting and scouting party spent two days collecting on Cat Island off the Gulf Coast of Mississippi. The party included T. S. Van Aller and W. C. Dukes of Mobile, Alabama, Doctor L. E. Miles, H. H. Kimball, H. L. Dozier, F. H. Benjamin, R. P. Barnhart, and R. W. Harned of the Entomological and Plant Board Staff in Mississippi, and J. E. Graf of the U. S. Bureau of Entomology.

Extensive Argentine Ant control compaigns have been put on at the following towns in Mississippi: Woodville, Crystal Springs, Durant, Starkville, and Laurel. This work is done in co-operation with the State Plant Board and the town authorities. Most of the work has been done under the direct supervision of Mr. E. R. Barber, of the U. S. Bureau of Entomology, assisted by Mr. Luther Brown, formerly of the State Plant Board of Florida, but now employed in Mississippi.

Mr. A. W. Morrill, formerly Arizona State Entomologist, has been located in Los Angeles, Cal., during the past year where he is managing entomologist of the Southwestern Alfalfa and Cotton Protective Service, a co-operative association of about twenty growers associations, extensive land owners, and business concerns having important interests in protection against alfalfa and cotton pests in the southwest, particularly against the alfalfa weevil, cotton boll weevil, Thurberia or wild cotton boll weevil and the pink bollworm.

Appointments to the Bureau of Entomology are announced as follows: W. A. Baker, Scientific Assistant, San Antonio, Tex.; R. C. Shannon, temporarily, Cereal and Forage Crop Investigations; James Zetek (part time) Panama project; R. E. Nolen, Camphor thrips, Satsuma, Fla.; Robert P. Colmer, James M. Langston, George F. Riley, J. B. Swift, Clifford G. Wallace, Joseph G. Hester, Jackson V. Vernon, George B. Ray, George L. Lott and Malcolm H. Mabry, all collaborators, Truck Crop Insect Investigations, under the direction of Professor R. W. Harned, Agricultural College, Mississippi.

The last legislature appropriated a total of $240,500 for the support of the State Plant Board of Mississippi. Among the chief activities of the Plant Board at this time are the following: scouting for the pink bollworm of cotton, Mexican bean beetle, sweet potato weevil, Oriental fruit moth, alfalfa weevil, and citrus canker; eradication of sweet potato weevil; eradication of citrus canker; Argentine Ant control; nursery inspection service; sweet potato inspection service; cottony cushion scale control; port inspection; enforcing quarantines against various pests, especially the pink bollworm of cotton.

Announcement has been made of the following transfers in the Bureau of Entomology: Julian J. Culver, Fort Valley, Ga., to Vienna, Va.; E. R. Skellregg, Dover, Del., to Fort Valley, Ga.; J. W. Jones, Arlington, Mass., to Carlisle, Pa.; D. W. Jones, gipsy moth work, Melrose Highlands, Mass.; to corn borer work, Arlington,

Mass.; Neale F. Howard, Bowling Green, Ohio, to Birmingham, Ala.; Fred A, Johnston, Kingsville, Tex., to Nogales, Ariz.; Francis F. Bibby, K. P. Ewing, R. C. Gaines and G. L. Plyler, boll weevil force to Federal Horticultural Board; E. R. Van Leeuwen, Cornelia, Ga., and W. D. Whitcomb, Yakima, Wash., temporarily to Fort Valley, Ga.

An important conference in regard to the Mexican Bean Beetle, *Epilachna corrupta*, that has recently been introduced into Alabama and now occurs in 12 counties in that State was held at Birmingham and Montgomery, Alabama, on September 20 and 21, 1920. Among those in attendance were: Doctor W. E. Hinds, State Entomologist of Alabama; Professor G. E. Starcher, State Horticulturist of Alabama; Doctor J. H. Montgomery of the State Plant Board of Florida; Professor A. C. Lewis, State Entomologist of Georgia; T. H. Jones, Entomologist of the Louisiana Experiment Station; Professor R. W. Harned, State Entomologist of Mississippi; W. J. Baerg, State Entomologist of Arkansas; C. H. Popenoe and J. E. Graf of the U. S. Bureau of Entomology.

Dr. Wilmon Newell has accepted the positions of Director of the Agricultural Experiment Station, Dean of the College of Agriculture and Director of the Agricultural Extension Division—all connected with the University of Florida at Gainesville, Florida. The appointment became effective January 12th last. Dr. Newell has not relinquished the position of Plant Commissioner, which he has held for the past five and one-half years. On the contrary, Dr. Newell will, in addition to the new duties he has assumed, continue to direct the plant pest control work and the police and regulatory activities of the State Plant Board of Florida.

During the Chicago meetings of the A. A. E. E. an organization of extension workers was formed, with the object of enabling the extension workers in the various states to keep in closer touch with each other, to enable them to take advantage of newly-discovered control methods, and to make possible the more rapid dissemination of knowledge of insect outbreaks which might spread from one state to another. Mr. E. G. Kelly, Manhattan, Kansas, was elected chairman. All those interested in such an organization are asked to communicate with Mr. W. P. Flint, Secretary, Natural History Building, Urbana. Illinois.

The Federal Horticultural Board has sent out a warning to the effect that French fruit seedlings now arriving in the country are heavily infested with browntail moth nests. Thorough inspection is urged upon all directly or indirectly affected by the possible establishment of this pest in new localities. Experiments are now in progess at Boston, Mass., to determine the possibility of killing the hibernating larvae by vacuum fumigation. There have also been repeated findings on shipments of French seedlings of the White Tree Pierid, *Aporia crataegi*, the larvae of which are general feeders on the foliage of fruit and wild rosaceous plants and oak trees in Europe. Inasmuch as there is a possibility of confusing the nests of these two species, it is suggested, if there be any doubt of the identity of the species, that that material be forwarded to specialists for determination.

Mailed March 9, 1921

# JOURNAL

OF

# ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 14 APRIL, 1921 No. 2

## Proceedings of the Thirty-Third Annual Meeting of the American Association of Economic Entomologists—(*Continued*)

*Morning Session, Thursday, December 30, 9.35 a. m.*

PRESIDENT WILMON NEWELL: The first paper on the program is by S. W. Bilsing.

## THE PECAN NUT CASE BEARER (ACROBASIS CARYAEVORELLA)

By S. W. BILSING

The pecan nut case bearer in its larval stage is the most important insect enemy of the pecan industry in Texas. The author has conducted a series of spraying experiments extending over several years to find a possible control for this insect.

There are three generations during the year. The larva of this insect passes the winter in the larval burrow at the base of the buds. These larvae become active about the time the buds start in the spring. The moths which come from these overwintering larvae begin to emerge during the latter part of April and continue to emerge for about twenty days. The eggs are laid in the center of the pistil of the nut from three to nine days after emergence. The egg hatches about five days after deposition and the young larva usually attacks the buds on the limb below the nut cluster. In a few days it returns to the nut cluster and begins boring into the nuts at the base. The nuts are attacked when they are very small, scarcely larger than an ordinary pea. The presence of a larva in a nut is indicated by the excrement and frass which projects from the opening at the base of the nut through which the larva entered. The nut drops to the ground after the interior is hollowed out and as the nuts are very small at this time one larva may destroy a large number of nuts before it has reached maturity. The larva reaches maturity

in twenty-five to twenty-nine days at which time it pupates within the nut. The nuts are usually webbed together by the larvae and the pupal stage is passed in nuts which are tied fast in this way on the tree. Altho there are three generations very little damage is done except by the first generation. Due to the fact that the nuts are so small at this time, the damage is little noticed. Sometimes the second generation destroys a considerable number of nuts but as a rule it is the first which does the major portion of the damage.

It was estimated last year (1919) that there were produced in Texas about one thousand cars of pecans. The past season (1920) there was almost an absolute failure of the pecan crop. Nearly all pecan growers are of the opinion that the failure was due to frost. The same opinion is given in reports of the United States Bureau of Markets. That such was not the case may be seen by examining the following tables. The following series of experiments were conducted at Corsicana, Texas, in an orchard of about six hundred trees. This place was admirably suited for such an experiment because all the trees are Halberts and about ten years old. A portion of the orchard comprising fifty trees were used in this experiment. These trees were about of the same size and age and according to the owner, Mr. J. M. Blackburn, of about the same bearing capacity. These trees were arranged as nearly as possible in plots of fours according to their size. Four were sprayed and the next set of four were not sprayed. Once each week the nuts from each tree which had fallen to the ground were collected and counted. The number which had fallen because of the attacks of the case bearer larva were tabulated in one column and those which had fallen from other causes were tabulated in another.

In spraying pecans it is necessary to use a first-class power sprayer which will maintain at least two hundred and fifty pounds pressure. One which will keep a pressure of three hundred and fifty pounds is better. One of the standard makes of spray guns is also desirable as more efficient work can be done with a spray gun than with a nozzle. The orchard was first sprayed May 8 with arsenate of lead at the rate of three pounds per fifty gallons of water. A second spraying was made May 22. These two applications were made for the first brood larvae. A third spraying was made on June 26 for the second brood of larvae. Some years it is necessary to make this application but the past season it was unnecessary since the number of larva of the second generation was so small that they did very little damage. In 1919 however, the second generation of larvae did considerable damage and this application was necessary. The control of the insect can best be accomplished in the first generation.

Another series of spraying experiments was tried in a pecan orchard at College Station with calcium arsenate which yielded negative results. As this orchard is about one hundred miles from the Corsicana orchard it is impossible to say at the present time if the difference was due to differences in rainfall or to the differences between calcium arsenate and arsenate of lead. It will be necessary to repeat this in order to determine the exact cause.

PLOT I—UNSPRAYED

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 1 | 817 | 68 | 19 | 904 | 90% | 10% | 2% |
| 2 | 1004 | 119 | 16 | 1139 | 88% | 12% | 2% |
| 3 | 1990 | 227 | 30 | 2247 | 89% | 11% | 1% |
| 4 | 309 | 38 | 0 | 347 | 89% | 11% | 0% |

PLOT II—SPRAYED

First Spraying ......May 8 ............................Arsenate of lead 3 lbs.; water 50 gal.
Second Spraying .....May 22 ..........................Arsenate of lead 3 lbs.; water 50 gal.
Third Spraying .....June 26 ..........................Arsenate of lead 3 lbs.; water 50 gal.

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 5 | 133 | 222 | 1140 | 1495 | 9% | 91% | 76% |
| 6 | 75 | 105 | 781 | 961 | 8% | 92% | 81% |
| 7 | 69 | 175 | 383 | 627 | 11% | 89% | 71% |
| 8 | 119 | 193 | 877 | 1189 | 10% | 90% | 74% |

PLOT III—UNSPRAYED

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 9 | 733 | 162 | 62 | 957 | 77% | 23% | 6% |
| 10 | 1149 | 226 | 35 | 1410 | 81% | 19% | 3% |
| 15 | 225 | 36 | 24 | 285 | 79% | 21% | 8% |
| 16 | 1165 | 235 | 30 | 1430 | 81% | 19% | 3% |

PLOT IV—SPRAYED

First Spraying ....May 8 ........................Arsenate of lead 3 lbs.; water 50 gal.
Second Spraying ..May 22 ........................Arsenate of lead 3 lbs.; water 50 gal.
Third Spraying ...June 26 ........................Arsenate of lead 3 lbs.; water 50 gal.

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 11 | 255 | 307 | 1008 | 1570 | 16% | 84% | 64% |
| 12 | 126 | 191 | 841 | 1158 | 11% | 89% | 73% |
| 13 | 81 | 213 | 908 | 1202 | 7% | 93% | 75% |
| 14 | 65 | 250 | 774 | 1089 | 5% | 95% | 81% |

PLOT V—SPRAYED

First Spraying ....May 8 ........................Arsenate of lead 3 lbs.; water 50 gal.
Second Spraying ..May 22 ........................Arsenate of lead 3 lbs.; water 50 gal.
Third Spraying ...June 26 ........................Arsenate of lead 3 lbs.; water 50 gal.

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent Infested | Percent Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 17 | 87 | 133 | 754 | 974 | 9% | 91% | 77% |
| 19 | 186 | 359 | 1001 | 1546 | 12% | 88% | 65% |
| 22 | 86 | 97 | 304 | 487 | 18% | 82% | 62% |

Plot VI—Unsprayed

| No. Tree | Dropped Nuts Inf. | Dropped Nuts Non. | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| 18 | 591 | 107 | 26 | 724 | 82% | 18% | 3% |
| 20 | 999 | 192 | 112 | 1303 | 77% | 23% | 8% |
| 21 | 469 | 95 | 18 | 582 | 81% | 19% | 3% |

Plot VII—Sprayed

First Spraying ....May 8 ........................Arsenate of lead 3 lbs.; water 50 gal.
Second Spraying ..May 22 ........................Arsenate of lead 3 lbs.; water 50 gal.
Third Spraying ...June 26 ........................Arsenate of lead 3 lbs.; water 50 gal.

| No. Tree | Dropped Nuts Inf. | Dropped Nuts Non. | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| 23 | 39 | 17 | 52 | 108 | 36% | 64% | 48% |
| 24 | 33 | 112 | 427 | 572 | 6% | 94% | 74% |
| 25 | 165 | 230 | 787 | 1182 | 14% | 86% | 75% |
| 26 | 237 | 176 | 635 | 1048 | 23% | 77% | 60% |

Plot VIII—Unsprayed

| No. Tree | Dropped Nuts Inf. | Dropped Nuts Non. | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| 27 | 1670 | 241 | 46 | 1957 | 85% | 15% | 3% |
| 28 | 568 | 112 | 12 | 692 | 82% | 18% | 2% |
| 29 | 723 | 145 | 58 | 926 | 78% | 22% | 6% |
| 30 | 222 | 28 | 40 | 290 | 76% | 24% | 14% |

Plot IX—Unsprayed

| No. Tree | Dropped Nuts Inf. | Dropped Nuts Non. | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| 31 | 1094 | 155 | 75 | 1324 | 83% | 17% | 5% |
| 34 | 683 | 54 | 10 | 747 | 91% | 9% | 2% |
| 35 | 681 | 62 | 0 | 743 | 92% | 8% | 0% |

Plot X—Sprayed

First Spraying ....May 8 ........................Arsenate of lead 3 lbs.; water 50 gal.
Second Spraying ..May 22 ........................Arsenate of lead 3 lbs.; water 50 gal.
Third Spraying ...June 26 ........................Arsenate of lead 3 lbs.; water 50 gal.

| No. Tree | Dropped Nuts Inf. | Dropped Nuts Non. | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| 32 | 120 | 262 | 904 | 1286 | 9% | 91% | 71% |
| 33 | 69 | 137 | 293 | 499 | 13% | 87% | 60% |
| 37 | 36 | 92 | 683 | 811 | 44% | 56% | 45% |
| 38 | 164 | 222 | 765 | 1151 | 14% | 86% | 67% |

Plot XI—Unsprayed

| No. Tree | Dropped Nuts Inf. | Dropped Nuts Non. | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| 39 | 653 | 45 | 8 | 706 | 92% | 8% | 2% |
| 40 | 187 | 40 | 13 | 240 | 78% | 22% | 5% |
| 41 | 451 | 31 | 0 | 482 | 94% | 6% | 0% |
| 44 | 967 | 93 | 16 | 1076 | 90% | 10% | 1% |

PLOT XII—SPRAYED

First Spraying ....May 8 ........................Arsenate of lead 3 lbs.; water 50 gal.
Second Spraying ..May 22 ........................Arsenate of lead 3 lbs.; water 50 gal.
Third Spraying ...June 26 ........................Arsenate of lead 3 lbs.; water 50 gal.

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 42 | 44 | 173 | 688 | 905 | 5% | 95% | 76% |
| 43 | 139 | 269 | 851 | 1259 | 11% | 89% | 68% |
| 45 | 24 | 68 | 326 | 418 | 6% | 94% | 78% |

PLOT XIII—UNSPRAYED

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 46 | 72 | 14 | 7 | 93 | 77% | 23% | 8% |
| 47 | 133 | 24 | 11 | 168 | 79% | 21% | 7% |
| 49 | 305 | 36 | 0 | 341 | 89% | 11% | 0% |

PLOT XIV—SPRAYED

First Spraying ....May 8 ........................Arsenate of lead 3 lbs.; water 50 gal.
Second Spraying ..May 22 ........................Arsenate of lead 3 lbs.; water 50 gal.
Third Spraying ...June 26 ........................Arsenate of lead 3 lbs.; water 50 gal.

| No. Tree | Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|---|
| | Inf. | Non. | | | | | |
| 48 | 14 | 35 | 121 | 170 | 8% | 92% | 71% |
| 50 | 70 | 116 | 253 | 439 | 16% | 84% | 58% |
| 52 | 32 | 58 | 137 | 227 | 14% | 86% | 60% |

SUMMARY—SPRAYED TREES

| Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|
| Inf. | Non-Inf. | | | | | |
| 2468 | 4212 | 15695 | 22375 | 11% | 89% | 70% |

SUMMARY—UNSPRAYED TREES

| Dropped Nuts | | Nuts on Tree Sept. 27 | Total Nuts Borne | Percent. Infested | Percent. Non-Inf. | Percent. on Tree Sept. 27 |
|---|---|---|---|---|---|---|
| Inf. | Non-Inf. | | | | | |
| 17860 | 2585 | 668 | 21113 | 85% | 15% | 3% |

MR. H. A. GOSSARD: What was the average cost per season for spraying a tree and what was the average return received per tree by the growers? I mean the cash return at the end of the season.

MR. S. W. BILSING: I havn't those figures present, but as I remember it cost about ninety cents per tree, including the cost of arsenate of lead and the labor and everything. The trees sprayed were about fifteen or twenty feet high. I think the returns above the cost were something between $4 and $5 a tree. I cannot now give the exact figures.

PRESIDENT WILMON NEWELL: The next paper is by R. L. Webster.

## FUMIGATION WITH HYDROGEN CYANIDE FOR THE CONTROL OF THE PEAR PSYLLA

By R. L. Webster, *Ithaca, N. Y.*

(Paper withdrawn for publication elsewhere)

Mr. H. A. Gossard: I would like to know if fumigation is a possible method for eradication in small areas? We have, so far as I know, only one center of psylla infestation in the state of Ohio, and this is very small With sufficient equipment, the work might be done in, say one night. Would there be any possibility of exterminating the psylla by this method?

Mr. R. L. Webster: I think you can very nearly do that. In the first orchard I fumigated in the spring of 1919, the psylla has not come back to be of any importance. That has not been true of other orchards, however, where there has been reinfestation from the outside. In one case there was considerable infestation from the timber adjacent. In some experiments which Professor Parrott made about three years ago, the psylla has not come back in sufficient numbers to require further treatment.

Mr. H. A. Gossard: I would like to ask if any one can report on the success that the California people have had from using balloons for the purpose of dropping these tents over large trees?

Mr. E. R. Sasscer: While on my way to California last spring, my attention was drawn to an article in, I think, *Popular Science Monthly*, to the effect that balloons were to be employed in placing tents over trees for fumigation. On my arrival in Alhambra, I asked Mr. Woglum if balloons were being used for the purpose stated, and he replied that some one had suggested their use, but so far as he knows, little progress has been made. It is safe to say that they are not at the present time being used in commercial groves.

President Wilmon Newell: The next paper is by Alvah Peterson.

## SOME EXPERIMENTS WITH PARADICHLOROBENZENE AND OTHER CHEMICALS FOR THE CONTROL OF THE PEACH TREE BORER, *SANNINOIDEA EXITIOSA* SAY

By Alvah Peterson, *New Brunswick, N. J.*

(Withdrawn for publication elsewhere)

Mr. George A. Dean: At what maximum depth were the larvae killed?

Mr. Alvah Peterson: The majority of the larvae are located above the point where the large roots branch from the tree. Worms below this point are few in number and are rather difficult to kill.

Mr. George A. Dean: Have experiments been carried on in connection with the woolly aphis?

Mr. Alvah Peterson: Mr. Blakeslee has shown that this material cannot be used on apple trees, as it seriously injures them.

Mr. William Moore: Many years ago, I think in the 80's, Hilgard of California pointed out that the phenomenon of adsorption is very important in the treatment of underground insects.

I would like to ask if Mr. Peterson has carried out any experiments on the adsorption of paradichlorobenzene by the soil?

Mr. Alvah Peterson: I have not.

A Member: I would like to ask what results have been secured with orthodichlorobenzene?

Mr. Alvah Peterson: Orthodichlorobenzene is a liquid and our experience shows that it is injurious to peach trees, and should not be used. We killed more than one hundred trees this summer by using it.

Mercuric chloride gives considerable promise of being an effective insecticide against the young borers in the trees. It was used in the same way that it has been applied in Canada for the control of the onion maggot. Further experiments will be conducted along this line.

Mr. H. F. Deitz: Where can paradichlorobenzene be purchased?

Mr. Alvah Peterson: From the Hooker Electro-Chemical Co., 25 Pine St., New York City; The Niagara Alkali Co., Niagara Falls, N. Y., or E. C. Klipstein & Sons Co., 344 Greenwich St., New York City.

Mr. A. L. Quaintance: I have been very much interested in the experiments reported by Mr. Peterson. They conform so closely to comparisons obtained by the Bureau of Entomology, that the members may be interested to know that there is available a publication on this subject and the treatment has already obtained large commercial use. It has been used extensively in the Ozark region of Missouri and Arkansas. In the peach belt in Georgia it has now been tried for two or three years on a large commercial scale, and we are in a position to judge somewhat of its effectiveness and its likelihood of injuring the trees. To date we have had no serious complaint of tree injury; on the other hand, we have had numerous assurances that this was the long-sought treatment for the peach tree borer.

President Wilmon Newell: The next is a paper by Mr. Glenn W. Herrick.

# THE CODLING MOTH—A QUANDRAY AND A QUERY[1]

By G. W. Herrick, *Cornell University, Ithaca, N. Y.*

Unquestionably the control of the injuries of the codling moth still constitutes the most important entomological problem confronting the apple grower in his attempt to produce clean, A-grade fruit, at least in Western New York. The serious phase of the problem to-day in the production of smooth fruit consists of the so-called side-worm injury in which shallow, circular, or elongated cavities are eaten out of the flesh of the fruit almost anywhere on the surface of the apple. This phase of injury which has assumed more and more prominence in the last few years has complicated the matter of control and it seems destined to modify our recommendations regarding the number and frequency of the applications of spray material. Indeed, certain entomologists as a result of their experience and observations have already shown a tendency to modify the emphasis which they have heretofore placed on the calyx spray and to extend this emphasis to subsequent applications of poison.

I was first impressed with the importance and complexity of this whole matter of side injury by Dr. Pettey's data in regard to the work of codling moth on pears in South Africa. His data were first embodied in an unpublished thesis and afterwards partly published as Bulletin 9 of the Department of Agriculture of South Africa (1916). Briefly, Pettey shows that comparatively few larvae enter the calyx cup of the unsprayed Beurré Hardy Pear while a very large number enter the sides. On the other hand, in the case of the Kieffer and Bosc large numbers enter the calyx and a much smaller number go in through the sides. A study of the calyces of these varieties shows that the calyx of the Beurré Hardy pear remains wide open "with a clean base due to the total disappearance of stamens and pistils" while the calyx of Kieffer, for example, shows a very complete closure. Petty concludes "that the greater the degree of closure of the calyx cup the greater the percentage of larvae that enter the calyx proper." This work of Petty's has certainly been suggestive and may throw some light on the problem of codling moth-control in this country.

Turning to the problem as it exists in the United States we may well consider briefly the significance of some investigations in this country. For example, Woodworth writing in 1913 said that in the Pajaro Valley in California it was observed that the great majority of the larvae entered elsewhere than through the calyx and that in Sutter county

[1]The nature of this paper is the result of the Secretary's suggestion that those who present papers "will discuss broad general topics rather than those of local interest."

only a third of the worms entered at the calyx. He also said "it was noticed that spraying was completely effective in the Pajaro Valley when applied long after the calyx is closed and in the Sacramento Valley good results followed when only two or three per cent of the cups showed an appreciable amount of the spray." He concludes with this significant statement "it will thus be seen that we do not know enough of the facts to explain the reasons for the efficiency of the poison".

Strickland (1920) has shown that this side-worm injury is abundant, and difficult to control in the apple region of Western New York in the Ontario plain region. He says, "a large majority of the larvae enter through the sides of the apple" and speaks of "this new factor of shallow and deep work of the codling moth" and of the importance of it because the defects will become more conspicuous when growers begin, as they surely will, to make a uniform pack based on color, size, and smoothness of fruit. He suggests the importance of applications of spray material subsequent to the calyx spray and seems to think emphasis should be placed on these later sprayings.

Childs (1920) says that during some seasons in Oregon "a very high percentage of the worms enter through the calyx and during others the reverse would be true." Apparently the proportion of worms entering the calyx and sides varies also with the variety. For example, Childs says, in an orchard of Spitzenburgs 66.96 per cent of the worms entered the sides while only 33.04 per cent were calyx worms. In a block of Newtowns 61.54 per cent were side worms and 38.48 per cent were calyx worms. On the other hand, in a block of Arkansas Black 31.68 per cent were side worms and 68.32 per cent were calyx worms.

It is perfectly evident that we haven't all of the facts concerning the larvae and their habits relative to their manner of entering the apple. Moreover, it would appear that the habits of the larvae in attacking the apple have an important bearing on the methods of control, especially on the manner in which the poisons should be applied. There is also another factor which I believe has an important bearing on this vexing question of control and that is, the great variation in the time of appearance of the codling moth in the spring from one season to another.

In our work with the codling moth in 1911 and 1912 R. W. Braucher, who carried out the work in the field, showed that the moths appeared and laid their eggs fully two weeks earlier in 1911 than in 1912. Strickland (1920) points out that in the Ontario region of New York, "the egg laying period for 1919 started ten days earlier than any other year since 1912" and the season of 1919 was what we may call a codling moth year. It appears from a superficial view of the work of the insect that in years in which it is abundant a greater proportion of the larvae enters

through the sides of the fruit. This, however, may not be borne out by a careful investigation of the actual facts.

When I consider the foregoing facts which have been inadequately and briefly stated I become lost in a quandry regarding the most effective method of control for the codling moth and the following questions suggest themselves:

1. Will it not be necessary for us to determine the habits of the larvae in any given region before being able to recommend reasonably effective control measures?

2. Is there a marked difference in the degree of calyx closure in different varieties of apples and if so is this a determining factor of the ratio of side and calyx entrants?

3. Should not this matter of calyx closure and its relation to the habits of the larvae be more fully investigated?

4. Do the rapidity and degree of calyx closure vary with the seasons and if so are they correlated with the ratio of side and calyx entrants?

5. Does the great variation in appearance of the moths in spring in different seasons bear any relation to the ratio of side and calyx entrants during that season?

6. Should not this whole question be investigated from a new angle and with a somewhat new viewpoint?

7. Is there not here a fine opportunity for a piece of cooperative research covering the whole apple area of the United States which may result in a fund of information on which we may be able to base more rational and effective methods of control?

It may be that the project is broad enough to be brought before the national Research Council for its aid and encouragement. Personally, I believe I could use a considerable sum annually for the next five years in a profitable investigation of this problem with the foregoing facts as a background.

The question is broad enough to interest the chemist and possibly the physicist. I am particularly impressed with the desirability of enlisting the chemist when I am reminded of the problem of the assimilation of some forms of poison and the non-assimilation of other forms by caterpillars and the consequent effectiveness of some arsenates and the ineffectiveness of others. I am also impressed with the possible aid that the chemist can give in this problem and perhaps the physicist also, when I recall the meager but very interesting and highly promising work that has been done with the so-called "spreaders" and "stickers" that have been added to poison spray materials to produce a complete and permanent film over foliage and fruit so that nowhere can a caterpillar find unpoisoned food. I believe we are on the threshold of important advances in control methods for insect pests.

My real query is, are we now making the most rational recommendations for the most effective control of the codling moth?

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1920 STRICKLAND, L. F.—*The Cornell Countryman*, Vol. XVII (April) p. 395.

MR. R. W. BRAUCHER: I can answer some of these queries partially from the experience that I have had in studying the codling moth in Michigan from 1908 to 1910 and in New York State from 1911 to 1913. In regard to the variation in the opening and closing of the calyx, I have observed a decided variation from season to season. In New York in 1912 we had some cold weather that retarded blossoming for several days followed by warm weather. The blossoms began to open on Friday, by Sunday they were in full bloom and the petals starting to fall. By Thursday the calyx on some of the Baldwins was closed tight and most of them too far closed for successful spraying. Some were even closed too much for successful spraying by Monday evening or Tuesday. In 1913 we had warm weather until the apple trees started to blossom when it turned cold with freezing weather. This season the calyx was open and in good condition for spraying for nearly a month. A crop was secured in spite of this unfavorable weather. Similar cases were observed in Michigan. At Lincoln, Illinois, in 1919 we had a hard freeze during the blossoming period with the temperature at 23 and 24 degrees two successive nights as recorded by a government maximum and minimum thermometer. This also retarded the closing of the calyx for two to three weeks but did not kill the fruit in healthy, sprayed orchards. The spring had been dry up to the time of the freeze.

In regard to side worms I have also noted marked variations. In Michigan in 1910 we had a very early spring with freezes during the blossoming period, resulting in the slow closing of the calyx and a short crop. Side worms were unusually abundant. The result of the spraying experiments carried on that year were very interesting but have not been published. These results convinced me that, under certain conditions at least, if the calyx is thoroughly filled with spray many of the codling moth larvae will enter the calyx but will leave it and enter the side of the apple.

MR. A. L. MELANDER: In dealing with the codling moth in the Pacific Northwest, we are emphasizing spraying for the first brood. The fruit grower who can give one or two or three thorough applications for the first brood usually has no fear whatever of side-entering worms. There

is one important thing that has usually been overlooked in codling moth control that year by year is impressing itself on me, and is perhaps one of its most important aspects, namely, the thinning of the fruit at the time that the first brood worms are in the apples. The commercial orchardist thins the fruit with an eye to taking off the wormy apples. The calyx spraying alone plus the thinning has frequently been all sufficient in producing one hundred per cent. clean fruit. Usually, however, the thinning is not perfectly done and the side sprays become necessary, but I do not know from personal experience how widely the thinning of the fruit is carried on in the commercial orchards of the Middle and Eastern States. It may be a totally impractical thing in the very large apple trees of New England and New York, but with the younger trees prevalent in the West, thinning for wormy apples is a regular accomplishment in codling moth control, and I believe it is worth as much as all the cover spraying put together.

MR. R. W. BRAUCHER: There is another point I would like to emphasize, and that is in the control of the codling moth there is a necessity of making a study of the insect each year and varying the spraying campaign to correspond with the life history of the insect during that season. There is such a variation between the life cycle of the codling moth and the life cycle of the tree that it is misleading to attempt to give recommendations according to the development of the tree. In one season you may get excellent results and in another season you may get very poor results.

The necessity of the cover sprays to prevent the side worms must be realized, and this method used much more extensively in certain seasons than in others on account of the difference in the abundance of the codling moth larvae.

Adjournment.

## Section of Horticultural Inspection

*Thursday afternoon, December 30, 2.15 p. m.*

The meeting of the Section of Horticultural Inspection of the American Association of Economic Entomologists was held Thursday afternoon, December 30, 1920, at the University of Chicago, and was called to order at 2.15 p. m. by the Chairman, Mr. J. G. Sanders of Harrisburg, Pa.

CHAIRMAN SANDERS: The Chairmen of this Section, in the past, have not been accustomed to give an address, but on the special request of the Secretary of the Section, the Chairman has prepared a short address which he will read at this time.

# THE TREND OF HORTICULTURAL INSPECTION

By J. G. Sanders, *State Capitol, Harrisburg, Pa.*

Horticultural inspection is essentially and perforce an American institution. It is a child of necessity—that need of a guardianship thrown around our agriculture and horticulture to protect them from the introduction and establishment of new and potential pests from foreign lands; likewise this guardianship is exercised to prevent, if possible, undue and rapid spread of pests already established within our borders, or those even more localized.

The history of our earliest endeavors along the lines of horticultural inspection and quarantines as reviewed at this period, reveals some admittedly unwise and drastic actions, which have hampered certain horticultural interests, and doubtless have caused, in the aggregate, considerable actual loss. I believe we are safe in our assurance, that zealous efforts to perform duty, sometimes perhaps in the absence of the best of training and experience, alone have caused unnecessary inconvenience and losses to horticulture.

Reports have been circulated that inspectors have condemned shipments without reasons other than to "show their authority," and to appear active in their positions. If there are such inspectors, they are not worthy of the consideration of decent men and scientific horticultural officers, and as such can not be too strongly condemned. The horticultural inspector who can not see the larger work, of which his effort is but a small part, and who is so untrained and so unobserving of the hosts of horticultural pests demanding constant alertness, that he must use unnecessarily drastic and ruinous orders, should be classed with the school examiner whose limitations of knowledge forces him to the use of "catch questions" to fill a list of only ten examination questions. Their day is past.

Great improvements are apparent everywhere in methods of inspection, certification, and quarantine. No longer do we frantically cut down large fruit orchards on account of a few individuals of the once dreaded San José scale. We have learned through a long series of years and experimentation to cope readily with this pest through spraying methods. This improvement in horticultural inspection is primarily the outgrowth of experience based on past history, on better training, better organization, and best of all, more general and hearty cooperation of existing agencies and factors.

A considerable change in feeling on the part of our nurserymen toward horticultural inspection is in evidence in these latter years, since they have begun to realize what they should have realized much earlier, that

the efforts of the horticultural inspector were directed primarily toward the salvation of horticulture. With dangerous pests threatening, the old days of a discordant attitude on the part of the nurserymen, we are glad to say, has in most instances changed to a satisfactory cooperation, and even in the instance of the more advanced type of nurserymen, a ready welcome, and even an invitation to visit the nursery stands at all times.

It is to the everlasting honor and credit of the American Association of Nurserymen that definite and organized steps are being taken by that body to purge itself of those nurserymen who have proven unworthy of membership in that body. If the activities of their vigilance committee can be judged as a criterion of their endeavors, the future holds forth bright promise of a distinctly elevated group of horticulturists in this national body. How desirable would have been such action a decade ago, but as Tennyson once said, "Science moves on slowly from point to point," so it seems that only by gradual degrees are we able to advance to better things. We should not be deceived, however, that all nurserymen have had a change of heart with respect to the inspection service of the states and Federal Government, because we may expect, as in any other line of effort the personal equation of mediocrity to appear and to offset a certain portion of the good intentions of the higher minded.

## State Cooperation

The horticultural inspection service at large deals with a problem which extends beyond the inspector's own realm, and his work at once becomes either a help or a hindrance to another in this line. It seems that at no time in our horticultural history is there greater need than at the present, for a closer cooperation of effort on the part of state officials among themselves, and with the Federal Government, for the protection of horticulture and agriculture. Agitation in various lines of inspection service toward closer uniformity in state laws governing materials which must pass eventually into interstate commerce, is becoming more and more general and mandatory, in order to insure the optimum conditions for interstate movement of such materials. This applies to the inspection of seeds, feeding stuffs and fertilizers, insecticides and fungicides, and materials of other types used for agricultural purposes, and produced by agriculture.

Several years ago a bill was drafted, covering practically all the phases of horticultural inspection which might be concerned in state inspections. This bill was approved by the National Association of Nurserymen, and by this organization, with the hope that the bill might be used as a model, and adopted wholly, or in part, in so far as local conditions permitted,

by those states contemplating new legislation, or changes in their existing legislation. Several states have already adopted this bill wholly, or in part, and experience has proved it to be sufficiently complete and fundamental for all ordinary purposes. This bill is to be commended to those who are contemplating alterations in their horticultural inspection laws.

The horticultural inspection service of our states at the present time varies too greatly in efficiency and thoroughness—to such a degree that it is questionable whether it is right and proper in some instances to reciprocate in the acceptance of certificate licenses. These conditions are caused by various inadequacies, some of which could be remedied by greater effort on the part of state officials.

One of the prime reasons for faulty inspection in certain states is the insufficient financial support whereby an inadequate force of trained men is employed during the inspection period. The fact that one state containing a considerable number of nurseries may be so unfortunate as to overlook a serious pest within these nurseries, due to lack of funds for sufficient inspection officials, and lack of time as a consequence, may permit its multiplication and distribution of the pest to other states. The state officials in such cases are not always to blame, but much of the blame for these conditions should be placed on the nurserymen of the state, whose lack of interest in their own business welfare, and that of others in similar pursuits, obtains in their failure to secure adequate appropriation to support the work. We have before us at the present time an enormous problem with the very dangerous and serious Gipsy moth, which has multiplied enormously in certain state nurseries, and probably has been shipped to many points within that state and other states. Although this condition is most deplorable, yet the entire blame cannot be laid on the officials who are charged with the inspection, but some of it should be charged to the nurserymen's association of that state, which has shown but little activity in past years in attempts to secure adequate appropriations for the safeguarding of their own interests.

Moreover, careless systems and methods of inspection, or almost total lack of system, combined with a force of untrained or inefficiently trained and experienced inspectors, has brought about a most deplorable condition in some states. I can speak frankly of the woeful condition, and lack of system and accuracy in the nursery inspection work in my own state, previous to 1917. In this particular instance, it was not due to lack of funds, but to a lack of system and trained inspectors, which served to perpetrate a wholly unsatisfactory and inefficient nursery inspection system. Are there not other states at this time, where, to a

degree at least, such conditions occur, that might be remedied by definite and determined action on the part of the state officials? Efforts should be made by every honorable means to secure adequate appropriations to be handled wisely, judiciously, and effectively, to better the horticultural inspection service.

## The Federal Inspection Service

Ever since the establishment of the Federal Horticultural Board, and during its activities, even to the present day, there has been in evidence varying amounts of definite and distinct opposition on the part of growers. In other words, the Federal Board has passed through, and is passing through, those stages and degrees of opposition with which the state officials have had to contend in the past two decades. It can be said, however, that much of this opposition has been engendered by a coterie of individuals in the florist and nursery business, many of them interested in the importing of foreign plants. In some of these attacks on the Federal Board, which have appeared in various floriculture and horticultural magazines, the writers of various articles apparently have been blind to the facts, or have ignored the actual truth, or treated it lightly in their statements. The members of the Federal Horticultural Board have been the victims of not only professional, but personal attack, almost entirely without warrant, because there is yet to be heard a single justifiable argument or reason why the Federal Board, or any member of it should seek in any way to bring disaster upon horticulture in this country.

Much of this opposition to the Federal Board in the past has been of a desultory nature, arising from various sources, appearing at inopportune times and places, and with an almost utter disregard of facts. At last there has been organized a committee, which proposed to delve into the facts of Quarantine 37 and its regulations, and this committee after a meeting in New York, prepared a preliminary report, which was sent broadcast over the country, and was printed in several magazines.

In justice to the Federal Board certain phases of this report should be discussed before this body, including corrections and denials of the committee's statements. First of all, unfortunately, this committee report is so drawn that an impression is conveyed to the public which is not warranted by facts. The statement appears that the quarantine has acted as an embargo, preventing the importation of any plants or seeds, except those permitted by narrow and seemingly arbitrary ruling. As a matter of fact, the great mass of plants imported, such as bulbs and fruit stocks, rose stocks, and similar material, have constituted the bulk of foreign importations, and it should be made clear that the forwarding

to Washington for examination, and possible fumigation, is best accounted for by the poverty of the Board, which is financially unable to extablish adequate port of entry inspection, which they have been willing to carry out, and will carry out, if sufficient funds are granted for it.

The committee report seems to promote the argument that Quarantine 37 "will create in America a horticultural and floricultural desert," and will prevent America from securing any of the new creations of plants from foreign countries. The wording found in the committee report leaves the above impression with the reader. There is no "Chinese wall plant policy for America" under the present system of quarantine and regulations, and any statements to this effect are unsupported by facts. The committee also reports that the work of botanical gardens has been either stopped, or disastrously checked, in so far as their research operations are dependent on plants obtained from foreign countries. When it is known that the liberal use of permits totaled more than five hundred to date, covering a period of about eighteen months, and that these permits included permission to import bulbs, ornamentals, orchids, roses, and other herbaceous plants totaling nearly eleven million plants, the fallacy of these statements can be realized. The policy of the Federal Board, on the whole, has been decidedly liberal in the interpretation of the quarantine and the regulations promulgated under it, so that although certain limitations and handicaps are placed on miscellaneous plant importations, there is little doubt in the mind of trained entomologists and plant pathologists that many potential pests will be barred entry into this country.

The application and enforcement of these quarantine measures will in the end have a beneficial effect on the great horticultural interests of America by encouraging them to produce or grow their own material, create and control to a large degree their own market and prices, and ultimately there will come a period when our horticulturists will endeavor to produce by their own efforts many of those finer creations which are so easily obtained from Europe by the exchange of American gold for European horticultural effort. A field will be opened up which will encourage young well-trained plant propagators to exert their effort, unhandicapped by the sudden importation of large quantities of new creations from abroad.

Every conscientious effort of the Federal Board to restrict the entry and establishment in this country of foreign plant enemies, and every effort made by them to restrict the spread of plant enemies already established in America, should receive the heartiest support and cooperation of the state horticultural inspection officials. It behooves the latter

group at this time to use every legitimate effort to offset the attempts of the enemies of Quarantine 37, who are putting forth a united effort at this time, to hamper the Federal Board, and to curtail its power. Every state horticultural official should keep in touch as closely as possible with the hearings, decisions, and actions of the Federal Horticultural Board, and should extend aid, cooperation, and sympathy wherever possible.

Now that Quarantine 37 is established as a law, and since it is the authority for which we have long been striving, no opportunity should be overlooked for maintaining the present quarantine law, and upholding its prompt and rigid enforcement.

CHAIRMAN SANDERS: The next paper on the program is along a somewhat similar line to that I have dwelt on in the latter part of my paper, and I will call on Dr. Marlatt at this time to speak on the "Recent Work of the Federal Horticultural Board."

MR. C. L. MARLATT: Mr. Chairman, ladies and gentlemen: I am very glad that your presiding officer, Mr. Sanders, has taken up the cudgels in defense of the Federal Horticultural Board. It relieves me of the necessity of saying very much about quarantine 37. The work of the Federal Horticultural Board covers such a number of items that the mere listing of them would occupy the fifteen minutes assigned to me. I shall, therefore, discuss some of the more important features only.

During the past year, the Board had its powers enlarged. They haven't been curtailed in any particular since the original passage of the Act, but there have been several amendments enlarging its powers. The one of the last year added a section giving power of control of plants and pests for the District of Columbia, such as is exercised by the different States, and action has already been taken under this power.

Another large addition to the work of the Board has been the extension of the Port Inspection Service. Under the increased appropriation of last year, some seventy-six thousand dollars, we have opened port inspection offices at New Orleans, Seattle, and some other ports, and have very much increased our service at the older ports where the main entries are made, namely, New York and San Francisco.

We are asking this year for another increase of $50,000 to still further extend this service, and more particularly to make provision for an equipment of scientific, technical men and laboratories for the inspection of imported plants at the ports of entry instead of at Washington. As Mr. Sanders has just said, the need of such port inspection applies largely to the so-called prohibited plants that come in under special

permits, but with respect to such plants we have issued permits for some fifteen million during the eighteen months of the quarantine. Those opposing the quarantine say that we have created a Chinese wall and this is going to be a desert country so far as new plants are concerned, but over fifteen million of those plants have been authorized entry. We have a well-equipped inspection force of entomologists and pathologists at Washington, but we have not had funds to establish similar forces at other ports of entry. We have, however, provided for inspection at San Francisco to avoid the necessity of having shipments cross the Continent and back again, where the plants are to find their final lodgment in some Western State.

This Port Inspection Service is one of the big things that the Board is developing, and it is under the direction of one of our most efficient men —Mr. Sasscer—who is one of your officers and who will probably tell you something more about it later.

The new quarantines during the year—I see a list of some nine here—show some activity in the line of placing further restrictions on entry or movements of plants and plant products. In addition to these, two or three others have been prepared but have not yet been issued.

I will simply read the list to give you an idea of the additions during this year.

Foreign quarantines include the flag smut and take-all quarantine on account of which the importation of grains is restricted.

The Mexican corn quarantine is to prevent the entry from Mexico of cotton seed and the pink bollworm with corn.

The European corn borer quarantine is one which you are familiar with. It may, however, be of interest to you to know that we have had to amend that quarantine to include brooms—manufactured brooms. Certain shipments of corn brooms from Italy when examined were found to contain whole stems of broom corn in the filling of these brooms. It was perfectly patent that it was possible to have insect pests come into this country through the agency of such manufactured brooms. These brooms were held up and after trying various other methods they were steamed. I may interject here that heat beats all other disinfectants. When you cook a worm once it is dead; you don't have to wonder whether the "insecticide" was strong enough or not!

The domestic quarantine on account of the European corn borer was revised to cover the extension of this pest determined in Massachusetts, New York, and Pennsylvania.

The Japanese beetle quarantine has been enlarged.

In the case of the moth quarantine, the brown-tail moth has been killed out by various agencies as indicated by Mr. Burgess, and we were actually able to reduce the area under quarantine.

The Mexican bean beetle quarantine is one which has been drawn and is now being held in the hope that we will get from Congress $150,000, a good portion of which will be for the enforcement of a regulated quarantine. If we don't get that money, in the absence of any State money, we will have to put on an absolute embargo to be enforced through the agency of the common carrier and through the cooperation of the officials of Alabama and surrounding States.

The pink bollworm quarantine in relation to Texas and Louisiana I will discuss a little later.

We have also issued a quarantine with respect to Porto Rico applying to Porto Rican cotton, and at the same time, revised the cotton quarantine in relation to Hawaii.

An important quarantine which lies on my desk and has not been completed for lack of time, because it involves a lot of consideration, is the first of a series perhaps which will require the cleaning at the point of discharge of load of railway cars which have conveyed and are fouled with plant products. I think this is one of the most important subjects that we have before us.

The Board is advised that it has no authority under the law to have a quarantine declared of the whole United States with regard to the whole railroad system, requiring such cleaning of cars, but that under a showing of some definite danger in a specified district such cleaning could be required as to such district, and we are preparing as the first try-out in that direction the requirement of the cleaning of cars that originate in the cotton states. There really ought to be a law, requiring all common carriers to thoroughly clean and disinfect cars at the time and place of discharge of loads as a condition of subsequent interstate movement. It would save a lot of distribution of pests.

Altogether we are now enforcing some ten domestic quarantines, eighteen foreign quarantines, and ten restrictive orders.

In addition to the administration of these numerous quarantines, we have the administration of some big projects; for instance, the importation of all foreign cotton, the pink bollworm control, the potato wart problem, and other problems of that kind.

I discussed this morning the cooperation of the Board in the administration of these quarantines with the related bureaus in the Department. Briefly, the quarantine administration and control comes under perhaps three classes: First, direct, where the Board is fully authorized by Congress to do all that is necessary to be done. That does not mean we don't cooperate even in these quarantines. Examples of these are the pink bollworm and the potato wart projects—one in which we cooperate with the Bureau of Entomology and the other with the Bureau of Plant Industry.

A second class is in relation to funds appropriated by Congress but without reference to a Bureau or office, but referred by the Secretary of Agriculture to joint control of the Board and the appropriate bureau. The corn borer appropriation (1920) is in this class.

Then we have a third class where the funds are definitely appropriated to the bureau or office and the quarantine feature comes under the cooperative control of the Board. There is quite a long series of these—the gipsy and brown-tail moth, wheat smut, pine blister, and Japanese beetle are examples. If we totaled the funds appropriated for all this quarantine and control work it would probably exceed $2,000,000.

The two big interesting problems of the year are the pink bollworm work in Texas and Louisiana and the South. and the administration of plant quarantine 37.

I think that at the last meeting of this Section I reported rather hopefully on the pink bollworm situation. Unfortunately, about that time, or a little thereafter, the insect reappeared in the old district in southern Texas and was discovered also in Louisiana. I think the details of those discoveries are probably familiar to all of you. This development led to a very large amount of activity on the part of the Board—getting extra funds from Congress for cleanup work and getting action and legislation from the States of Texas and Louisiana.

I wish every State in the Union in the presence of an emergency like the appearance of the pink bollworm in Louisiana would take the same sort of enthusiastic, thoroughgoing, heroic action which the State of Louisiana took. The State enacted laws giving full authority and appropriated $225,000, and has carried out the program, which is even more important.

Texas was laggard, I regret very much to say. The Secretary of Agriculture became very much interested in the matter. We had conferences in Washington which were addressed by the Secretary of Agriculture, and finally at the request of the Governor and of the Legislature of Texas the Board went to Austin, Tex., and remained there for a considerable period to aid the Legislature in enacting a suitable pink bollworm law. Unfortunately, due to active opposition and consequent delay, the Legislature was not able to perfect the legislation and the law as passed has large defects. For example, it does not provide for immediate noncotton zones. Several such zones can begin only with 1921. It abandoned, by oversight I think, the border zone which had been established for two years. It limits destruction to fields of cotton actually found infested, and hence prevents regional destruction of growing, maturing cotton, and it requires further that any noncotton zones established shall be reestablished every year instead of continuing until the order is lifted.

In spite of these difficulties we have gone ahead with cooperative work in Texas, and the people of the State have given us such cooperation as practically to give the control which we would have had under an adequate law. Noncotton zones, of course, could not be enforced, but in point of fact nature came to our rescue as to the Trinity Bay district with a climate that was unfavorable over much of the area where we should have had a noncotton zone, and in effect produced such zone.

You will be interested in knowing our point of view relative to the outlook for extermination. We do not believe it is hopeless. The insect has not appeared at any new point in Texas except at El Paso. The old Trinity Bay district is very much smaller in its area of infestation than it was in 1917 and in 1919, and the infestation that has been found in it has been of a very scattering nature. In the two other districts in Texas where we have had the pest before, it did not appear at all in 1920, namely, the Pecos Valley and the Hearne districts.

In Louisiana there has been no reappearance in the three parishes and only one new point in the State—at Shreveport—and this has been vigorously taken hold of and will be noncotton next year.

We believe therefore that there is an opportunity still to exterminate the pink bollworm, We have now before Congress an estimate for an emergency appropriation of $100,000 to finish up the work of this year. We are also asking in our regular appropriation for about $660,000 for work for 1921–22.

There is a particular strength of argument which we can make with relation to these special appropriations. They are not like research work; they are not like educational work which, if not done, causes the public no irreparable harm; you can give that same demonstration, the same education another year! In the extermination of a pest like this, or like the citrus canker, you have the opportunity once and once only; if you let it get away you cannot take it up another year!

We have also a large Mexican border service on account of the pink bollworm. This subject is on your program for later discussion.

We have discontinued, for the time being, the research station in the Laguna, but what I think will be a very authoritative and interesting document is now going through the press, giving the results of the research there for the last two years.

Incidentally, one of the most important pink bollworm developments of the year has been the sending of a commission to the Laguna by the Governor of Texas—a commission involving in its personnel all the big cotton and farming interests of Texas,—brainy men who have large influence in that State. The sending of this commission was to determine whether the entomologists were magnifying the situation, and

whether the pink bollworm was really doing the damage charged to it. As a result of minute examinations this commission determined that the loss from the pink bollworm for 1920 was fifty per cent. of the crop. Their report to the Governor made a tremendous impression upon Texas and is going to help the whole situation.

The other large element of Board work is the control of plant and seed importations. Your Chairman, Mr Sanders, has helped me out very considerably in his discussion of this subject. This service is under the direction of Mr. Beattie, who will tell you more about it later. There are in the country large numbers of very estimable people, many of them of great wealth, who are interested in orchids and roses, and who are members of local amateur societies, garden societies, flower societies of all kinds, who have been seized upon by the small bunch of aggrieved importers and have had their souls filled with distrust of the Federal Horticultural Board and its works in relation to quarantine 37.

An informing statement on quarantine 37 has been prepared and will be issued shortly to make available accurate information relative to this quarantine.

In spite of assertions in recent propaganda, America will not become a desert, not with some 15,000,000 so-called "forbidden plants" authorized entry in eighteen months! The fact is that we authorized the entry of about four times as many as could be found abroad to purchase! You understand that this entry of foreign plants is not a violation of the spirit of the quarantine. These plants cannot be sold. These plants are permitted entry for the sole purpose of introducing new varieties and propagating stock and from such introductions to grow in this country new stocks,—American grown—which can be sold. In other words, we are developing in this country the production of the plants which we formerly imported.

This quarantine now has the general support of the commercial plant growers of the country. Many men come into my office who have been fighting the quarantine vigorously in the past, and after some hesitation it finally develops that what they are really interested in is, if the quarantine is going to stick, whether we have got backbone enough to stand up for it! They go away satisfied!

CHIARMAN SANDERS: Your Chairman feels that he would have been sadly remiss if he had restricted Mr. Marlatt's talk to the fifteen minutes that was stated on the program, because there are only a few of us here who have the opportunity to frequently get in touch with the Federal Board and to be in attendance at the hearings and meetings, and I feel

that what Mr. Marlatt has given us today is extremely instructive as to the aims and objects of the Federal Horticultural Board.

The next paper on the program is by T. J. Headlee.

## THE PRESENT STATUS OF THE GIPSY MOTH IN NEW JERSEY

By Thomas J. Headlee, Ph.D., *State Entomologist, New Brunswick, N. J.*

One year ago it was thought that New Jersey did not entertain the Gipsy Moth within her borders just as many other states in this country now believe that they are not acting as hosts for this insect. In July 1920 caterpillars of the Gipsy moth were found feeding upon both evergreen and deciduous foliage within the limits of Duke's Park near Somerville. It was evident from the outset that the infestation was of long standing and probably large. Mr. A. F. Burgess, in charge of the Moth Control Service for the United States Government was promptly invited to meet the New Jersey authorities and to examine the situation. Messrs. Burgess, McIntyre, Weiss and the writer went to the Somerville district on the arrival of the two above gentlemen first mentioned, and after a cursory examination of the situation, during which Mr. Burgess discovered a vigorous specimen of *Calosoma sycophanta*, sat down to plan out the procedure.

Logically it seemed that the first thing to be done was to find out the extent of the local infestation and the second thing was to find out whether the Duke Farms Company had disposed of any of its surplus trees, where in the park area such disposal may have originated, and where such material as had been disposed of had been sent. Mr. Burgess agreed to send into New Jersey some of his trained gipsy moth scouts to make a preliminary survey, and Mr. Weiss agreed to look into the business relations of the Duke Farms Company relative to the question of sending out surplus stock.

Accordingly the gipsy moth scouts made their appearance a couple of weeks later, and before they had finished with the Somerville area determined that at least ninety (90) square miles were scatteringly infested. It seemed that the center of the infestation lay in a thirty acre block of blue spruces. Inasmuch as these spruces were imported not less than ten or more than twelve years ago from Belgium and Holland it seemed likely that the infestation was brought over with the blue spruces at that time. Owing to the relatively unfavorable nature of the spruce foliage the insect had been a number of years in getting sufficient start to move out of the spruce. Furthermore, the egg masses were darker colored than those found in New England and this fact supported the belief that the infestation originated in Europe.

Mr. Weiss investigated his phase of the problem and furnished to Mr. Burgess as complete a list as could be secured of the business done. It should be understood at this point that the Duke Farms Company is not essentially a nursery concern; but constitutes the management of the personal estate of Mr. James B. Duke, developed for his pleasure and that of the public. The trees in the plantings were set close together, in order that in spite of natural losses there should still remain an adequate stand. As a matter of fact the stand proved more than adequate, and as the trees grew it became necessary to remove a considerable number from time to time and plant them elsewhere on the estate, burn them up or sell them. The first and third types of action were adopted by the Duke Farms Company and in 1913 they applied to the New Jersey Inspection Force for a certificate permitting them to ship.

Mr. Weiss procured apparently a list of the shipments of surplus stock that had been made and turned that portion of the list which was concerned with shipments outside of the state to Mr. Burgess for further action. Mr. Burgess then, furnished the officials of the various states with a list of the shipments that had gone into their states. In such states as did not have the men to follow up these shipments he sent his own scouts. Mr. Burgess further furnished some of the personnel of the force which scouted the points to which shipments from the Duke Farms Company had gone intrastate. In the course of the scouting of sections to which shipments had gone intrastate slight and recent infestations were found at Glen Rock, Wyckoff, Paterson, Elizabeth, South Orange, Mendham, Scotch Plains and Deal Beach. The egg masses in these outlying points ranged from one to nearly eight hundred. In all cases where egg masses were found in the outlying districts by the scouts they were treated with creosote.

At the writer's request Mr. Burgess called a meeting in New York on August 24th (before the Glen Rock, Paterson, Scotch Plains and Mendham infestations had been found) to which were invited Mr. J. G. Sanders of Pennsylvania, Mr. George G. Atwood of New York, Mr. Weiss of the New Jersey State Department of Agriculture and the writer. The writer took occasion to invite the Secretary of the New Jersey Department of Agriculture, Mr. Alva Agee, and the Director of the New Jersey State Department of Conservation and Development, Mr. Alfred Gaskill. At this conference an estimate of the funds needed to combat the gipsy moth infestations in New Jersey, New York and Pennsylvania on an exterminative basis was considered. Mr. Sanders reported that he had destroyed the infestation, root and branch, on the Schwab estate and that in all probability no funds, other than those provided by the State, would be needed in Pennsylvania. Mr. Atwood's

representative did not feel the same way and seemed to desire some government aid. Mr. Burgess indicated that already the United States Gipsy Moth appropriation was $150,000 shy, and New Jersey stated that the proposition in that state was sufficiently large that government aid would be most decidedly welcomed. Briefly stated the budget as prepared to combat the insect on an exterminative basis for the first two years was as follows:

To June 30th, 1921—New York $50,000; U. S. Government $150,000; New Jersey $100,000. In addition to the exterminative work in New York and New Jersey, the United States authorities decided to ask for $150,000 to supply the deficiency on the gipsy moth work in New England, making a total request on the part of the United States of $300,000 and on the part of the states of $150,000.

To June 30th, 1922—New York $50,000; U. S. Government $200,000; New Jersey $100,000. In addition to the request for exterminative work the United States authorities decided to ask for $400,000 for the suppression work in New England.

The total government request for the fiscal year ending June 30th, 1921, as set forth in this conference was $300,000 and the total for the fiscal year ending June 30th, 1922 was $600,000. The total New York request for the fiscal year ending June 30th, 1921, was $50,000 and the total request for the fiscal year ending June 30th, 1922 was $50,000. The total New Jersey request for the fiscal year ending June 30th, 1921 was $100,000 and the total request for the fiscal year ending June 30th, 1922 was $100,000. It was understood that, as far as the relation between the United States authorities and the New Jersey authorities were concerned, $100,000 of the appropriation for the fiscal year ending June 30th, 1921 was to be available for work against the New Jersey infestation, and it was also understood that during the fiscal year ending June 30th, 1922 another $100,000 of the government appropriation should be available for work against the New Jersey infestation. It was decided that outlying infestations in New Jersey could be cleaned up in two years, but that the Somerville colony would require five years, and that state and government should be requested to finance the last three years on a fifty-fifty basis.

After the writer had time to think the matter over thoroughly, he decided that, in view of the problem of exterminating the outlying infestations and in view of the fact that many of the large estates within New Jersey's limits had never been scouted and, in view of the further fact, that these estates were probable sources of danger, further provision should be made for exterminative work against the outlying areas and for the scouting of the large estates and such other danger points as

might be thought advisable. Accordingly, instead of requesting the Legislature at its meeting on November 8th for the sum of one hundred thousand dollars, he requested the immediate appropriation of the sum of one hundred and twelve thousand dollars. He is happy to report that the bill was introduced, passed by both houses and signed by the Governor within less than seven hours; the money thus appropriated becoming immediately available. He plans during the months of January and February to request the Legislature of New Jersey to appropriate the sum of one hundred and twenty-five thousand dollars for the fiscal year beginning July 1st, 1921, and ending June 30th, 1922. This extra twenty-five thousand dollars is planned for supplementary exterminative work against the outlying infestations and for the scouting of the large estates and other danger points.

In addition to the above appropriation, Mr. J. B. Duke, being familiarized with the nature and the extent of this infestation before the state appropriation was made, agreed to make available private funds to the amount of twenty-five thousand dollars. This action was a most welcome one for it was felt that a thorough dormant season scout would reveal a greatly increased area of infestation in the Somerville district.

Since the securing of the funds from the State Legislature another infestation has been discovered at Mendham. The egg masses here almost exactly correspond to the masses found in New England. Neither the size nor the origin of this Mendham infestation has been determined.

Early in the consideration of the exterminative work against the gipsy moth in New Jersey, Mr Burgess informed the writer that by December 1st, all government moneys available for work against the gipsy moth in New Jersey would be exhausted, and that no further funds could be provided until the meeting of Congress in December. Furthermore, Mr. Burgess pointed out that spraying machinery for the spring work against the gipsy moth would have to be ordered very promptly, or it would not be ready in time for next spring.

Beginning previous to December 1st the New Jersey State Department of Agriculture began to take on its pay rolls a large number of gipsy moth scouts and foremen, who were drawn from the New England forces. Crews were located in the Somerville area and at various outlying points. Mr. H. A. Ames was designated by Mr. Burgess and Mr. McIntyre as a satisfactory man to take general charge of the work. A central office has been established at Somerville, and Mr. Ames has been permanently located there. At the present time there are about eighty gipsy moth scouts working in the state, of whom fully two-thirds are experienced men drawn from the New England forces and officered

by foremen, general foremen and an executive from New England. About one-third are New Jersey men, who are learning the work of scouting for the egg masses. Arrangements have been made to purchase eleven new high powered truck mounted sprayers for use during the coming spring.

For the protection of other parts of the state and of other sections of the United States, the entire Somerville area has been included in a quarantine, which covers something like 200 square miles, and this quarantine is being administered in conformance to the plan governing the same sort of work in New England, and is being endorsed by Mr. Ames and the group under him. Furthermore every point at which infestation has been found has been placed under a similar quarantine, which is being conducted in the same way. While these quarantines are intrastate in character, by reason of the source from which they came, they are operating also as interstate quarantines.

Thus it appears that the New Jersey infestation of the gipsy moth is being attacked upon an exterminative basis and that a determined and well considered effort is being made to prevent infestation passing from the areas already infested into uninfested portions of New Jersey and into other states. This problem would not have been attacked on an exterminative basis, were it not for the fact that the New Jersey authorities were assured by Mr. Burgess and his aids, after they had been carefully over the territory, that extermination was entirely a practicable matter.

In all this effort against the gipsy moth, the Japanese beetle has not been forgotten, and it is expected that the Laboratory working for the control of this insect will be adequately supported by the United States Government and the States of New Jersey and Pennsylvania.

The discovery of an injurious insect, such as the gipsy moth, within the limits of any state does not, it seems to the writer, constitute a justifiable basis for criticism of the force operating in that state; but rather should be taken as an evidence of activity on the part of that force. Such a discovery becomes a justifiable basis for criticism only when the inspection force is adequate to meet the situation, and there are few inspection forces in any of the states in this country which are adequate. Something like six or seven years ago the writer proposed, at a public meeting of the New Jersey State Department of Agriculture, the appropriation of funds to institute and to support an insect scouting and survey service with the idea that the large estates of New Jersey should be combed and that any other danger points should be very carefully examined. This suggestion received little attention and came to naught as has been the fate of other efforts of a similar kind in other parts of this

country. It seems that a severe epidemic of some kind is necessary to induce the people of our democracy to extend adequate support to preventive organizations and measures. In this connection the writer would like to point out that California's inspection service is the result of a fear that the citrus industry would be wiped out, and that Florida's efforts are the natural and normal result of the fear that its citrus industry would be destroyed by the citrus canker. He anticipates that this severe experience with the gipsy moth will lead the citizens of New Jersey to support a twenty-five thousand dollar insect and disease survey service; thus putting New Jersey in a position to protect herself against the establishment of serious insects and diseases in so far as such action on the part of the state is humanly possible.

In view of the acknowledged insufficiency of our present inspection service in most of the states of this country, and in view of the fact that about the number of years necessary for infestations, established ten or twelve years ago, to make their appearance, and in view of the further fact that a well supported insect and plant disease survey service affords the greatest practical measure of protection, it seems to the writer that every state should make a determined effort to put on and maintain an insect and plant disease scouting and survey service, which is at least approximately adequate. It is now just about ten years since the period when the gipsy moth egg masses came to this country in immense numbers, and it is entirely probable that far more infestations of this insect have become established than any of us dream of.

CHAIRMAN SANDERS: I am sure we are glad to have this authoritative statement by Mr. Headlee on the present conditions in New Jersey.

MR. BURGESS: If there is an opportunity to discuss this I would like to make a supplementary statement. There have been found in addition to what Mr. Headlee has indicated, four infestations in New York State. Three of these are on Long Island, and one in the Hudson Valley. Stock from that estate was shipped to the Park Department in the city of Buffalo, and the trees were used for resets on the street to replace trees that had died, and it has been necessary to scout the city of Buffalo in order to determine that infestation had not made a start in that city. That work has been done by men on the Bureau force. Work of a similar character should be done in Brooklyn and in other points in New York State. I would like to call attention at this time to the financial situation in connection with the gipsy moth project. Last year I told this Association that the gipsy moth situation was extremely critical and that with the $300,000 appropriation which we had ordi-

narily received we would not be able to do the work that should be done in New England. We asked for $400,000. We received $250,,000 and in addition to that, shortly after the first of July, we also learned of the large infestation in New Jersey which made the problem extremely difficult, to say the least. Dr. Headlee has indicated what has been asked for in the way of appropriations: $300,000 additional money for the present fiscal year, that is from the present time up to the first of July; and $600,000 for the following fiscal year.

The estimates were approved by the Department of Agriculture. An emergency bill was drawn for the $300,000 and is being considered by Congress at the present time. The funds for field work are exhausted with the exception of a few thousand dollars, and practically all the field men are either being carried on the New Jersey, Connecticut, Massachusetts or Vermont pay rolls. This condition cannot last very long and unless the emergency appropriation is made available very soon, we are going to have extreme difficulties a little later in the season.

Under present conditions we are not in a position to contract for the necessary equipment or poison for spraying work in the Spring, and the situation is indeed very serious. I think all of you will be glad to know just what the condition is with respect to the gipsy moth problem at the present time.

Chairman Sanders: Your Chairman will take this opportunity to appoint a Nominating Committee who will select a Chairman for this Section, also a Secretary, the Chairman who is to be approved by this Section for final election as third Vice-President of the American Association. I appoint Mr. Dietz and Mr. Cotton to serve, and I will ask them to be ready to report at the end of the program.

The next paper on the program is by O. D. Deputy, to be read by Mr. Sasscer, and illustrated with lantern slides.

## ACTIVITIES OF THE FEDERAL HORTICULTURAL BOARD ON THE TEXAS-MEXICAN BORDER

By O. D. Deputy, *Laredo, Texas*

The placing of an actual inspection force on the Texas-Mexican Border by the Federal Horticultural Board was begun late in the spring of 1917, it having been previously determined that there was Pink Boll Worm infestation in the Laguna district of Mexico and that seed from that locality was being brought to the border for exportation to the United States. For the needs of this paper it will suffice to say that a ban was immediately put on all cotton seed from Mexico and that an inspection force was shortly recruited whose main duty it was to keep all such

seed out of this country. Incidently, there were other quarantines against other Mexican products that were to be enforced. In order to accomplish this multitude of duties, it has been necessary to inspect all passenger traffic and the baggage pertinent thereto as well as all railway cars, fumigating a large percentage of the latter.

The inspection of the railway cars from Mexico had to be performed in Mexico because the functionings of the Mexican and American Customs Departments are such that, when once a car has crossed the international boundary, it is supposed to have legally entered the country, and the regression of the same is nothing short of the work of a day. The initiation of this mode of inspection was an onerous task, indeed, and many a wrench was thrown into the machinery of inspection by uninformed Mexicans who could not understand why the entry into the States of a few stray cotton seed in the cracks of railway cars should be objected to; nor could they see by what manner of logic we could presume to make such inspections in Mexico. So presumptuous did the men performing the work appear to them and so odious the requirements of the regulations that they straightway gave the men engaged in the same the name "Picudo," meaning in Spanish according to their application, "long nosed, nosey individual." Nor was this the only indication of a lack of co-operation for the American shippers were of the mind at first that the inspection was too exacting and that the regulations were too stringent. Finally, however, by diligently explaining the need for the inspections and by fair treatment of each case according to its merits, the inspectors caused the work to gradually gain in favor, until now it is indulgently tolerated if not particularly sought after.

The inspection of a car is after all a dry matter-of-fact proposition that does not readily lend itself to a colorful, attractive description. In a word it consists of jumping into the door of a car and looking into all of the available cracks for cotton seed. But surprising it is how adept the men become at finding, in a short time, all of the cotton seed contamination that a car contains. Adept they must be too when it is remembered that at times it falls to the lot of one man to inspect as many as ninety cars in a day. Disposing of an empty car is a comparatively easy task for it is either free from contamination and is certified to cross or else it is fouled with seed and entry is prohibited until such a time as the shipper has had it cleaned to the satisfaction of the inspector. It is not until cars containing cargoes are found to be contaminated with cotton seed that difficulties are experienced. If such a car containing ixtle, lead, beer, or other such free shipping article, transferring the same under supervision is a small task. On the other hand, if the cargo happens to be bulk material such as ore, bone, or bat

guano and it is found to be fouled, it becomes necessary to devise such a procedure as will reduce to a minimum the possibility of any cotton seeds passing into the United States when the load itself is permitted to enter. In the case of ore it is thinly spread, saturated with oil, and burned over; bones are sprayed with oil; while guano, if fine enough, may be screened.

That the inspection of cars might be carried to a successful termination, it has been found expedient that there be a certain amount of paper work connected with its execution. To fill this need a car record card has been adopted which shows on the face of it where the car came from, its ultimate destination, whether it is inspected or not, its condition at the time of inspection, and if the car has entered the United States. Under the conditions which the work operates this information is indispensible and, having the same, the inspectors are assured of keeping a tight rein on the movement of cars out of Mexico.

Before the subject of car inspection is left it might be well to mention that no less than a third of all cars inspected are found to contain cotton seed and that in numerous cases live Pink Boll Worms have been found in seed taken from such cars. The latter statement is particularly applicable to the ports of Laredo, and Eagle Pass, Texas. This in a word comprises the work done in Mexico.

From the very outset the Board required the fumigation of certain cars. At first pot fumigation was practiced and two ounces of sodium cyanide per hundred cubic feet of space were used, but later the dosage was reduced to one and one-quarter ounces when the cars were fumigated in the fumigation houses which the Board put into operation October 1, 1919. The erection of these houses was largely due to the untiring efforts and enthusiasm of Professor R. Kent Beattie who drew up in their entirety the plans for the houses. These buildings which were made of brick were so constructed and their doors fitted with such an exact nicety, that one car or a number of cars could be placed therein and the compartment containing the same would be practically air-tight.

On one side of the house is an auxiliary room where the gas is manufactured. The machinery used in the generation of this gas is simple in design. For the sake of clarity it may be described as consisting of three tiers of tanks; the first of which is composed of an acid drum and two large tanks for stock solutions of sodium cyanide; the second is comprised of measuring tanks for the cyanide solution, acid, and water that they may be introduced into the generators in the proper proportions; and the third tier consists of the generators proper in which the gas is generated and from which the gas goes to the various chambers

of the house. All of the generators, measuring tanks, and storage tanks are inter-connected by pipe manifolds so that, if one of the various pieces of machinery composing the battery becomes incapacitated, another may be substituted for the same.

There are four fumigation plants at the several border points: one at El Paso with a capacity of fifteen cars, another at Laredo with the same capacity, while those at Brownsville and Eagle Pass are smaller, they permitting the fumigation of six and eight cars respectively. At Del Rio such a house as will accommodate vehicles is maintained. All told, it is now possible to fumigate on the Texas-Mexican Border two hundred and fifty cars a day in these houses. Although, owing to the subnormal conditions in Mexico, only about 15,000 cars are fumigated per annum, the houses have an annual fumigating capacity of 60,000 cars.

To carry on fumigation even on a 15,000 car per annum basis requires large quantities of sodium cyanide and sulfuric acid. At present some eighty or ninety tons of cyanide and ten or twelve cars of acid are consumed yearly. To meet all expenses covering supplies, labor, and miscellaneous materials incidental to fumigation, a self-sustaining feature has been introduced into the work, in other words, the cost of fumigation is assumed by the Department of Agriculture but a charge is made to cover the actual labor, other than supervision, and the chemicals used. At first the fee for each car treated was five dollars but later, owing to the elimination of wastage and the reduction of labor required, this fee was reduced to four dollars. It is altogether possible that further reductions in the cost of operation may be made. In fact, there is a concerted effort on the part of everyone connected with the work to practice every economy in keeping with good business that this service may be rendered at the least possible cost to the shipper.

Another problem presented itself for the consideration of the Board when in the early part of 1920 Mexico commenced to export huge quantities of corn. Ordinarily the conditions are reversed and large shipments of corn are imported into Mexico but in 1920 the corn crop had been especially large and high prices prevailed in the States; hence, this unusual movement of corn out of the Republic. All of the corn was shipped already shelled and it soon developed that most of these shipments were fouled with cotton seed, the theory of contamination being that the shippers in Mexico had stored the corn in the same bins that they had previously used for storing cotton seed. It was impossible to eliminate this contamination by mechanical means and it became necessary to prohibit the entry of the corn unless certain conditions were met. These conditions were that, either the corn be ground to fine meal or that it be sterilized by heating it uniformly to a tempera-

ture of 200 degrees Fahrenheit for five minutes. In either case the work was to be done under the supervision of an inspector of the Board. None of the corn was ground but sterilizers for treating it were installed at El Paso, Laredo, and Piedras Negras, opposite Eagle Pass. The machine at Piedras Negras works on the theory of exposing the corn to currents of air which have been previously heated by passing them over a core of steam pipes; while the machines at Laredo and El Paso function on the principle of heating the corn by exposing it to confined steam. Through the above agencies a much needed product was allowed entry into the United States without endangering in any way the agricultural pursuits thereof.

The last but in no way the least important or interesting duty which has evolved itself on the shoulders of the Federal Horticultural Board is the performance of the foot bridge and passenger inspections. The one takes place at the footbridge and pertains to local resident people and tourists who go back and forth between the towns situated on either side of the boundary; while the other, the passenger inspection is confined to travelers from the interior of Mexico. The latter work is relatively simple because there is no attempt ordinarily to conceal, hide, or smuggle prohibited material. It is mainly through ignorance on the part of the traveler that quarantined products are offered for entry. Nevertheless, it has been proved that this ignorance might have been the means of adding more trials to the already many agricultural tribulations of the United States had not inspection been practiced. It is recalled that on one occasion some ninety weevil-infested avocadoes were confiscated from a tourist who was taking them to California to experiment with growing Mexican avocadoes in the avocado growing section of that state. On several occasions numerous live Pink Boll Worms have been taken from immigrant passengers who were using seed cotton for filling pillows. These are only a few classical examples; there is never a day that many confiscations are not made.

The local footbridge traffic is quite a problem. The greatest offenders are the Mexicans who live on the American side or pioneer residents who have developed a seemingly unmanageable appetite for Mexican fruits. They may be likened to an ungovernable child and the inspection at the footbridge resolves itself into a contest of matching wits with them. In some cases where attempts to smuggle have been made, some rather unique methods of concealment were resorted to. On one occasion a party of four women presented themselves at the foot bridge. For some reason their deportment excited the suspicion of the Customs Inspectress, who detained them. No prohibited material was found in their hand baggage, but when their clothing was searched two cloth bags,

of such a shape and size as to be easily concealed, were found about the waists of two of them. These bags contained a total of twelve avocadoes and three mangoes. On another occasion a Mexican woman, who had been stopped, proved herself so undependable when questioned, that the inspector on duty persuaded himself to break open what appeared to be a perfectly normal loaf of bread. It contained several avocadoes. The woman had gone to the trouble to bake a thin crust of bread around a small number of avocadoes. Then there are the old and often tried practices of hiding prohibited material in the pockets, under a large sombrero hat, or concealing it in the pockets or under the seats of automobiles and buggies. New tricks are constantly being tried, but these are good examples of the methods used and show how persistently people try to bring in material in violation of the law. At Eagle Pass an average of 1,500 passengers at the foot bridge are inspected each day; this average is increased to 5,000 at Laredo; while at El Paso the inspector at the footbridge has to supervise the crossing of some 10,000 persons daily.

There are in all at the different border ports, twenty-four Plant Quarantine Inspectors who are schooled in the various activities of the Federal Horticultural Board and each of the twenty-four is performing a signal service for the country at large.

CHAIRMAN SANDERS: The next paper is by Professor F. M. O'Byrne of Gainesville, Florida.

## STANDARDIZED NURSERY INSPECTION

By F. M. O'BYRNE

There is almost constant agitation by the nation's nurserymen for a uniform nursery inspection law. The many varying inspection laws are confusing and troublesome. They feel that the laws should be so changed that the inspection provided in each state will be sufficient to carry plants from any state to any point in the Union.

While the advantages of such laws are obvious, I frankly despair of ever seeing them in force. Pests that are the most destructive in the South are often ignored in the North, and vice versa.

This does not mean that it is impossible to standardize nursery inspection laws the nation over. There are many conflicting requirements that can be eliminated.

The following suggestions, while not complete, will indicate points on which standardization is desirable:

1st. All inspection certificates in the United States should expire on the same date, probably September 30th.

2d. License fees, for nurseries both within and without the State, should be eliminated. License fees greatly increase the number of clandestine and illegal nurseries. To charge a higher fee to ex-state nurseries than to state nurseries is unjust and discriminatory.

3d. Fumigation requirements as to plants required to be fumigated, dosage, and time of exposure should be the same in all states.

4th. The question should be settled as to whether anything less than an inspection of every plant in a nursery will suffice for the issuance of a certificate. (We think it should not.)

5th. A list of plants that must be dipped should be agreed upon by all states, and the strength of the dip and the manner of dipping should be specified.

6th. All states should require a valid and unaltered certificate of inspection of uniform size and appearance attached conspicuously to the outside of each box or other container of nursery stock. To have such certificates uniform in size and appearance will enable the transportation agents to co-operate. Certificates of all sizes and wording, etc., make easy the counterfeiting of certificates. The Florida tag has proved satisfactory. It is printed on a No. 8 raw hide tag with a brass eyelet. The certificate is at the top; the space for the address is in the middle and the return address and shipping instructions of the nurseryman are at the bottom. Writing the name of the addressee or consignee on the tag is required. This cancels the tag and prevents its illegal re-use. We believe that the writing of the consignee's name on the certificate tag should be a uniform requirement.

7th. If any other marking is required on the package it should be the same throughout the states.

8th. Each state should make the same requirements of out of state nurseries that wish to do business within the state. It doesn't matter so much to the nurseryman what he has to do, provided the requirements are the same in all states.

9th. Quarantines should be standardized and should follow as closely as practicable those of the Federal Horticultural Board.

10th. Nurserymen should be required to purchase their certificate tags from their State Nursery Inspector. Each tag should bear a different number and the nurserymen should be required to account for each tag received by filing with the Inspector a

record showing how each tag was used. This record or invoice should give the name and address of both the nurseryman and purchaser, date of shipment, an accurate list of the plants shipped and the number of the certificate tag used thereon. In other words, an invoice. If, at the end of the season, it is found that the nurseryman has failed to account for any tags issued him, the missing records should be promptly called for.

This requirement is one of the most important. It should have a place in every state's inspection scheme. Nursery Inspection laws are for the protection of farmers and horticulturists. To protect themselves they secured the enactment of such laws, with the mistaken idea that a highly trained inspector could look at a tree and tell whether it was free from insect pests and diseases. The farmer and horticulturist want protection, and under the ordinary nursery inspection system they are neither getting what they want nor what they are paying for. Is this charge fair? Let us see.

This nation's nursery inspection laws were passed primarily to stop the spread of San Jose scale. Did they stop it? No; San Jose scale has probably been shipped under the certificate of every Nursery Inspector in the United States.

Consider the host of pests that have been spread on nursery stock in the last few years: fire blight, cottony cushion scale, white pine blister rust, Oriental peach moth, wooly aphis, crown gall, Japanese beetle, chestnut blight, citrus canker, and so the list goes. Citrus canker entered Florida on certified stock from two, and perhaps three different states and from Japan. It was passed, I believe, by Federal Inspectors. It was shipped all over our State on certified stock: proof that inspection alone, no matter how rigid, is insufficient. There are many reasons why inspection alone cannot give proper protection:

1st. A nurseryman has large sums invested in his business. If you find some pest in his stock you can't condemn it all whether you actually find it infested or not and require its absolute destruction. He would fight such a ruling in the courts and would usually win. You must compromise with him by arranging a fumigation, or some other such precautionary treatment—and then the pest spreads.

2d. An inspector is practically helpless when dealing with a new pest. He can not put on a blanket quarantine that will damage or ruin a nurseryman every time he sees a new spot; he must watch developments for awhile. If eventually he finds that it is a serious pest he knows, to his chagrin, that stock he has been certifying as apparently clean has been carrying that pest.

3d. It is impossible for an inspector to detect any disease in its incipiency. There is always an incubation period after infection when it is impossible for an inspector to tell whether the plant examined has the disease.

4th. Most of us will admit that we are unable to do our inspection work as thoroughly as we would like, because of lack of funds.

5th. Occasionally nurserymen will conceal the presence of a pest from an inspector by having the nurseryman's own employees inspect before the inspector's coming, pulling tell-tale leaves and twigs and spraying with a protective covering of Bordeaux with *plenty* of lime in it.

6th. The best inspection service in the world will only stop the most severely infested stock. No inspector can get it all, not if he has all the time and money in the world. The entire history of horticultural inspection proves this. It has probably retarded the spread of pests—but what pest has it actually stopped?

If taken in time, a pest can be eradicated completely for less than will be expended on it yearly in control measures alone, if not eradicated. One of the most important points in any eradication campaign is to have on hand a list of all points to which infected or suspected material has gone. This makes eradication possible at a reasonable figure.

In these days of world wide trade, and with the possibility of new pests being introduced on so many different products, it is a foregone conclusion that any quarantine service inaugurated by the Federal Horticultural Board, or state agencies will be merely a sieve which will barely keep out the most apparent, dangerous and easily intercepted pests. If only 80 percent. efficient, that quarantine service is thoroughly justified, but there are still one-fifth as many chances of our getting new pests, and they are going to keep coming in as long as we continue to trade with the outside world.

If these statements are true, no inspection service is adequate that stops with inspection only. If it is to give proper protection it must provide, for instant use, a complete record of all nursery stock moved with its sanction and permission.

The advantages of this arrangement are many and important:

First, it gives the Inspector a record as to where every plant that he certifies is planted. If he finds that a pest in Mr. A's nursery is very serious, he has only to go to his file, take out Mr. A's folder and he has instantly a complete record of the points to which Mr. A's stock has been shipped.

Second, these lists are valuable for other purposes. They show the State Horticulturist where the biggest plantings are being made: What the most popular varieties are: How the varieties differ in different sections of the State: How much and what kind of nursery stock is coming into the State: Whether a state exceeds in its imports or exports of nursery stock, etc. Much information of value to state officials is constantly to hand in these lists.

Third, they often enable the Inspector to nip in the bud a violation of the law. If an invoice passes through his hands that clearly indicates a violation, he can act promptly. If it raises his suspicions he can investigate. The invoices coming through the Florida office have given us the necessary clue on five or six occasions in the last four years.

Fourth, it stops the use of invalid and altered certificate tags so common in most states, for at the end of the year the nurseryman is required to return all unused tags to be canceled or destroyed by the Inspector. Then there are no invalid tags on hand to get mixed with the valid ones, or to tempt altering on the part of the frugal nurseryman.

Fifth, it stops the dangerous practice, so common in most states, of misusing certificate tags. Certificate tags are legal documents: They should not be used as address tags for shipping ordinary express and freight. To so use them is to lower their importance and significance in the eyes of transportation employees. But the most dangerous practice and one that is all too common in many states, is the intentional misuse of a certificate for deception. For example: Mr. Brown goes to the transportation office with a package of uninspected stock. The transportation agent refuses to accept the shipment because "there is no certificate tag attached." Mr. Brown goes home with his bundle, calls at Mr. Ray's nursery and "borrows" one of his certificate tags. This he attaches to his bundle and marches proudly and virtuously to the transportation office, often not realizing that he is violating the law, and not caring. He may strike a different agent at the transportation office, or if he strikes the same one the agent will not read the certificate and notice the discrepancy: Who ever heard of a transportation agent reading a certificate tag? Even if the agent should notice the discrepancy, what could he do? Nothing. The law says there must be a certificate tag attached to each package of nursery stock shipped. The law doesn't say that it must correspond in name to the shipper. If the tag is attached the agent's responsibility ends and off goes the shipment of uninspected stock under a certified tag—more dangerous than if it had no tag attached. Do you think this never happens in your state? It is happening in most states every day during the shipping season as the interceptions by the Florida Quarantine Department

prove. If Nurseryman Ray had to account to his State Inspector for each tag received, and the misuses of a certificate was prohibited under penalty of the law, he would refuse to give Mr. Brown a certificate tag.

Six years ago Florida had a disasterous experience which made the inherent weakness of the ordinary nursery inspection system very apparent. We have developed a system which overcomes this weakness. It has worked successfully for five years.

The time has come when nursery inspection requirements should be standardized to eliminate the many needless confusing and unimportant variations. We owe this to the nurserymen, the horticulturists and ourselves. The numbered certificate plan should be adopted as a standard requirement. The Nursery Inspector who ignores it is assuming a grave responsibility.

CHAIRMAN SANDERS: The next paper is by H. F. Dietz.

## SOME PROBLEMS IN GREENHOUSE INSPECTION WORK IN INDIANA

By HARRY F. DIETZ, *Department of Conservation, Indianapolis*[1]

The total value of the greenhouses of the United States is between $75,000,000 and $100,000,000. In Indiana alone there are 4,500,000 square feet of ground covered by greenhouses conservatively valued at $5,000,000. Our State ranks seventh among the commercial flower-growing states of the Union, being surpassed only by New York, Pennsylvania, New Jersey, Illinois, Massachusetts, and Ohio. Little thorough work relating to the life history and control of the most common and destructive of these insect pests or plant diseases has been done. The florists have been left largely to shift for themselves and to devise control methods good, bad, and indifferent. Generally only in cases where the destruction of an entire crop has been threatened, through the spread of a serious pest such as the chrysanthemum midge, have entomologists as a whole aided the florists.

The problems arising in the inspection and certification of greenhouse plants for intra and inter state shipment have not been given the careful and thorough consideration they deserve. The writer does not presume to say how these problems should be dealt with, but will point out and illustrate by specific cases, the problems that have arisen in Indiana in order to awaken an interest in the matter.

[1]Published with the permission of the Director of the Department of Conservation and the Chief of the Division of Entomology.

It is necessary here to point out that there is a very important difference between greenhouse grown plants and nursery stock at the time each is distributed. Nursery stock is dormant when shipped. The leaves are off and practically all soil is removed from the roots. There are some exceptions as in the case of conifers and other evergreen plants. On the other hand plants grown under glass are generally shipped in a growing condition. Except in the case of cuttings and bud-wood, defoliation is out of the question and so is the removal of soil from the roots. Therefore, any insect or disease attacking the leaves, stems, or roots, are generally carried with the plants.

The first problem is, "What shall we regard as 'clean' plants?"—in other words, "What are plants free from dangerously injurious insects and plant diseases?" The following list of greenhouse insects (including mites) and plant diseases has been arranged in accordance with the prevalence of the pests in Indiana greenhouses (See p. 190).

It is evident that many of the tropical and sub-tropical insects, such as the mealy-bugs and scale insects listed, are serious pests in California and Florida and along the Gulf of Mexico; therefore, their very presence in a greenhouse ought to be sufficient grounds for refusing the grower a permit to ship plants to the regions mentioned. The terminal inspection systems in use in California and Florida will prevent infested stock from entering these states. Yet, should the presence of these pests warrant the refusal of a permit to ship when the plants are grown for northern distribution only, and where perhaps the only persons who will have trouble with them will be florists and their patrons? This distribution of, in most cases lightly infested, plants from florist to florist and from florist to patron has lead to some interesting results. Ten years ago the coleus was one of the most popular bedding plants in Indiana. But today that popularity has decreased so far that few florists grow this plant, and all this is due to mealy-bugs. The florists could not, or did not, keep these plants free from the pest with the result that when the plants were bedded out with others during the summer it was only a matter of time until the other plants, as well as the coleus, were infested and the bed ruined. The patrons of the florist have learned that the coleus is a plant not to buy because of the danger of their being infested with mealy-bugs.

Many Indiana florists have also discontinued the growing of palms and other subtropical plants used for decorative purposes because of the difficulty they have had in controlling the tropical and subtropical scale insects attacking them. Ten years ago a greenhouse was incomplete without a stock of palms and other tropical decorative plants. Such plants usually went from bad to worse year by year and as they died

## INSECT PESTS INCLUDING MITES

| Pest | Host on which it may be distributed |
|---|---|
| Red Spider (*Tetranychus telarius* Linn.)[1] | Roses, carnations, chrysanthemums, smilax, palms, aspidistra, etc. |
| Mealy Bugs (*Pseudococcus citri* Risso and *P. adonidum* Linn.)[2] | Coleus, geraniums, palms, rubber plants, Boston and related ferns, dracenas, etc. |
| Greenhouse White Fly (*Trialeurodes vaporariorum* Westw.)[2] | Pelargonium, fuchsia, primulas, celestial peppers and ornamental solanums. |
| Greenhouse Thrips (*Heliothrips haemorrhoidalis* Bouché)[2] | Rose, carnation, chrysanthemum, croton, aspidistra, *Ficus* spp. azalea, etc. |
| Plant Lice | *Aphis rufomaculata* Wilson and *Macrosiphum sanborni* Gill. on chrysanthemums[1]; *Macrosiphum rosae* Linnaeus on rose[1]; *Myzus persicae* Sulzer on carnations[1]; *Aphis gossypii* Glover on begonias, Easter lilies[2]?; *Cerataphis lataniae* Bdv. on Kentia palms.[2] |
| Boston Fern Scale (*Hemichionaspis aspidistrae* Sign.)[2] | On Boston and other ferns, aspidistra. |
| Chrysanthemum Midge (*Diarthronomyia hypogaea* F. Lw.)[2]? | Species and varieties of the genus *Chrysanthemum* |
| Greenhouse Leaf-tier (*Phlyctaenia ferrugalis* Hübn.)[1] | Chrysanthemum, cineraria, primulas, carnation. rose. |
| Rose Midge (*Dasyneura* [*Neocerata*] *rhodophaga* Coq.)[2]? | Roses. |
| Rose or Oblique-banded Leaf-roller (*Archips* [*Cacoecia*] *rosaceana* Harr.)[1] | Rose, carnation |
| Florida Fern Worm (*Eriopus* [*Callopistria*] *floridensis* Guen.)[2] | Various genera, species and varieties of greenhouse ferns. |
| Soft Scale (*Coccus hesperidum* Linn.)[2] | Ferns, palms, crotons, ornamental citrus plants, camellia, *Ficus* spp., bay trees, orchids, etc. |
| Hemispherical Scale (*Saissetia hemisphaerica* Targ.)[2] | Same as Soft Scale. |
| Oleander Scale (*Aspidiotus hederae* Vall.)[2] | Palms, cycads, ornamental citrus plants, orchids, bay trees, *Olea fragrans*. etc. |
| Florida Red Scale (*Chrysomphalus aonidum* Linn.)[2] | Palms, *Ficus* spp., ornamental citrus plants, *Pandanus veitchii*, *Dracena indivisa*, aspidistra, cypripediums. |
| Boisduval's scale (*Diaspis boisduvalii* Sign.)[2] | Palms, orchids (Cattleya spp.). |
| Strawberry Root-worm (*Paria canella* Fabricius vars. *aterrima* Oliv. and *quadriguttatus* Lec.)[1] | Roses? Soil (larvae). |
| Cyclamen Mite (*Tarsonemus pallidus* Banks)[2]? | Geranium, cyclamen, chrysanthemums, snapdragons. |
| Chaff Scale (*Parlatoria proteus* Curt.)[2] | Ornamental citrus plants, orchids (Vanda spp.). |
| The Crazy Ant (*Prenolepis longicornis* Latr.)[2] | In peat around orchids (*Cattleya* spp. and *Vanda* spp.) Only one record from Indiana. |
| The Greenhouse Orthezia (*Orthezia insignis* Dougl.)[2] | Coleus. Only one record from Indiana greenhouses, other hosts are lantana, verbena, chrysanthemum, gardenia. |
| The Argentine Ant (*Iridomyrmex humilis* Mayr)[2] | Pandanus, dracena, dieffenbachia, and aspidistra. See text p. 193 for a discussion of this insect. Has not been found in Indiana. |

| Disease | Host on which it may be distributed |
|---|---|
| Root and Stem Rot (*Rhizoctonia* sp.) | Carnation. |
| Wilt, Stem Rot or Die Back (*Fusarium* sp.) | Carnation. |
| Carnation Rust (*Uromyces caryophillinus* [Schrank] Winter) | Carnation. |
| Bud rot (*Sporotrichum poae* Peck) | Carnation. |
| Wilt (*Fusarium* sp.) | Chrysanthemum. |
| Anthracnose (*Gloeosporium rosae* Halsted) | Rose. |
| Cane Blight (*Coniothyrium fuckelii* Saccardo) | Rose. |
| Crown Gall (*Bacterium tumefaciens* Erw. Smith and Townsend) | Rose. |
| Rust (*Puccinia anthirrini* Dietel and Holway) | Snapdragon. |

[1]Holartic insects [2]Tropical or semitropical insects.

were replaced by others. Infested plants served as a harbor for scale insects and a source from which plants like ferns, which were often grown in the same house, became infested. When a florist sold a palm or similar plant he often got it back during the winter as a "boarder." Often he took it back in spite of his better judgment and set it among his own plants which he had fought hard to keep clean. In view of these facts should the grower who takes in "boarders," which are generally scale infested, be allowed to ship plants to another grower in another state who does the same thing? Or, if not, to what treatment should lightly infested plants be subjected to kill any infestation of scales or other insects occurring on them?

Ferns are delicate plants and when they become infested with insects it is practically impossible to "clean them up" without injuring the plants. Hence, what disposition should an inspector make in the case of ferns that show a very slight and scattered infestation of any of such scale insects as the soft scale, the hemispherical scale, or the Boston fern scale? It is needless to point out that a grower of ferns free from these insects is always afraid of introducing these pests on plants he buys. One florist in a small Indiana city bought several thousand fern plants infested with soft scale from a large grower and distributor in another state. These he unwittingly set among his clean stock with rather disastrous results. How can occurrences like this be best prevented?

The rapid spread of the chrysanthemum midge shows what may happen when a serious greenhouse pest becomes established in the greenhouses of one or more large growers. In 1914 it was known only from the houses of one large chrysanthemum grower, but by 1917 eight of the large distributors in widely separated parts of the United States had serious infestations. Fortunately we know now how to control the insect and most of the larger growers in Indiana have it under absolute control and several have practically exterminated the pest in their greenhouses. Nevertheless, its spread is continuing. In 1916 when widespread warnings were disseminated many of the smaller growers, such as local florists, became frightened and refused to buy mum plants for two or three years. But during the spring of 1919 and 1920, lead on by the high price of cut flowers, many florists "plunged" heavily on mums. Even those who bought only such plants as they needed of some new and popular variety often got the midge with them. One large distributor got an infestation in this manner. He fortunately did not buy any chrysanthemum plants from 1914 to 1919 and as a result had no midge. In 1919 he bought 200 plants of a new variety and luckily escaped the pest. But in 1920 he bought 250 plants of a

new variety from a jobber and with them came a light infestation so that this fall not only the plants he bought but two of his own varieties were infested slightly.

In many respects the rose midge is like the chrysanthemum midge. Though this insect has been known in the United States since 1887, its outbreaks have been more or less sporadic and probably dependent on the distribution of new varieties which have served as favorite food plants. The last distribution and resulting outbreaks of this pest took place with the dissemination of the popular rose, Ophelia. There is little doubt but that the plants, sent out by one of the several distributors of this variety, were infested with this midge. Ophelia is a fine seed parent and also shows a tendency to "sport" easily. Many of its "sports" and seedling offspring are held in high esteem by the florists and are constantly gaining in popularity with the flower-buying public. The reason I have mentioned this fact is that Indiana observations indicate that some of these sports and seedlings show the same susceptibility to the attacks of rose midge that their parent does and there are indications that another outbreak of this insect over wide areas is going to result.

The greenhouse white fly, because of the range of host plants it attacks, is very troublesome. It is difficult to control, especially when hydrocyanic acid gas is not used. Florists who have not had experience with this insect often scoff at the idea that it is a serious pest. But many Indiana florists have changed their minds regarding its importance. Those who have attempted to grow semi-hardy perennials like buddleia and bouvardia under glass or those who have lost a crop of indoor asters through its attack do not think it a pest of secondary importance. Those who grow fuschias, salvias, primulas and celestial peppers know that it is no easy task to control white fly. Yet one can find growers of some of its favorite food plants who have little or no difficulty in holding the insects in check, often without resorting to cyanide fumigation. In view of these facts what disposition should an inspector make of plants lightly infested with white fly?

Those insects and mites that occur out-of-doors in the northern two-thirds of the United States but have invaded greenhouses, like the red spider, the greenhouse leaf-tier, the rose leaf-roller, and the strawberry root-worm, present an interesting case. The first and the last named become serious pests out-of-doors but the other two do not seem to be nearly as serious pests in the open as under glass. If Indiana experiences are to be taken as a basis, it is safe to assume that both the leaf-tier and leaf-roller have been far more widely distributed through the medium of infested hosts than through the invasion of the greenhouses by moths,

or caterpillars, in widely separated localities. We have noticed that when any large grower and distributor has an outbreak of these two pests it is not long before a number of the smaller growers who have bought from the infested source have an outbreak. Hence, shall the presence in a greenhouse of any of these insects mentioned, even though they are being held in check successfully, warrant the withholding of a certificate of inspection?

The tropical ants are pests that seem to be gaining a foothold in our northern greenhouses. One of our florists bought a large collection of orchids from a jobber. With these he got the following insect pests,—a heavy infestation of *Parlatoria pergandii* Comst. on vandas, a heavy infestation of *Diaspis boisduvalii* Sign. on cattleyas and a scattering infestation of *Coccus pseudohesperidum* Ckll. and *Targionia biformis* Ckll. (both new coccid records for Indiana) on the same host. But what is probably more important than all these scale insects, he got a heavy infestation of the crazy ant—*Prenolepis longicornis* Latr. with nests in the peat in which the orchids were growing. Just what the outcome of its introduction into this Indiana greenhouse will be, remains to be seen. What action should the state in which this shipment originated have taken? And what action should the State of Indiana take to prevent the further distribution of this insect?

It is a common thing for Indiana florists to buy plants like aspidistra, ficus, *Dracena indivisa* and *Pandanus veitchii* that have been grown out-of-doors (or with slight protection in the winter) in the southern states. I was amazed to find that the greenhouses where a large southern distributor of aspidistras grew these plants were alive with the Argentine ant. What action should be taken to prevent the spread of this insect, northward?

Though comparatively little is known about greenhouse insects, far less is known about most of the diseases attacking plants grown under glass. There is carnation rust, the Fusarium root rot, and the Rhizoctonia branch and stem rot on this host. There is the snapdragon rust which has spread over the whole United States in the past twenty years. The widespread distribution of this disease might at one time have been checked. On roses we have such diseases as anthracnose and cane blight. There are doubtless many others which will attract attention following intensive study. Should the presence of any of the diseases mentioned in a greenhouse warrant the withholding of a certificate of inspection? Can infected plants be sent under a qualified certificate of inspection? Are these diseases dangerously injurious?

At present, three alternatives are open to state inspectors relative to plants grown under glass. The first is to let any and all persons who

desire to ship greenhouse plants do so on the grounds that such plants do not come under the regular nursery inspection requirements. Technically this view is correct. The second alternative is to inspect the plants and issue a certificate if the plants are free from insect pests and plant diseases at the time of inspection and if measures are being taken by the grower to keep them so. The third alternative is to issue qualified certificates of inspection provided there are no dangerously injurious insects or diseases present or new and uncommon ones which are very restricted in their distribution. Certain combinations of these three alternatives are in use in some states. In these cases if a grower is refused a certificate of inspection he can ship his plants by merely attaching a statement to them that they are greenhouse grown and are thus exempt from inspection. Thus the man who grows clean stock for distribution is at a disadvantage in that he must compete with the one who does not. Also in such cases anyone who wants to sell greenhouse plants, no matter how badly they are infested with insects or infected with diseases, can sell them and there is nothing in most states that will protect the buyer of these plants except the contract he has with the man from whom he is buying.

Now if the certification of greenhouse plants is undertaken what shall the basis of such certification be? How often and when shall the plants be inspected? Thirty days will often change the entire aspect of the insect and disease conditions in greenhouses. If there is but a single inspection when shall that be? The presence of the rose midge may not even be suspected if an inspection is made from December to March. Chrysanthemum midge, especially where a light infestation occurs, might be overlooked if the inspection were made during the summer, from the last of June to the first of October. During the months from December to April only the most careful inspection would reveal the occurrence of the strawberry root-worm.

In general, it might be said that two inspections, one in the summer and one in the winter, ought to give the inspector a good idea not only of the insect and disease conditions in a given greenhouse but also an idea of the grower's ability to "clean up" his plants and keep them so.

Chairman Sanders: We are glad to have these observations on a rather new line of inspection which is coming more and more to the front in this country, particularly in some of the larger states where florists' establishments occupy an important place in horticulture.

If there is no discussion of this paper, we will proceed to the next number by J. E. Graf of Maccleny, Florida.

## SWEET POTATO WEEVIL ERADICATION TESTS IN FLORIDA

By J. E. GRAF and B. L. BOYDEN, *Bureau Entomology*

(Withdrawn for publication elsewhere)

CHAIRMAN SANDERS: The next paper is by J. H. Montgomery.

## PLANT QUARANTINE WORK AT FLORIDA POINTS

By J. H. MONTGOMERY, *Gainesville, Fla.*

Plant quarantine inspection at ports of entry is a development of comparatively recent date. The State of California was the pioneer in this kind of work and 30 years ago recognized the necessity of not only preventing the spread within the State of pests which were already present but also of preventing the entry of pests from outside her borders. In this work she has been preeminently successful and the methods made use of by California have formed the basis for similar work by other states and countries which have since seen the wisdom of applying the principle expressed in the old proverb about the ounce of prevention being better than the pound of cure. The Japanese Imperial Plant Quarantine Service is modeled after that of California. The Federal Horticultural Board has recognized the efficiency of California's system and the State Plant Board of Florida, when it contemplated inaugurating a similar service, made use of California's long and successful experience. So far as I am informed, California and Florida are the only states which maintain a protective first line of defense in the form of a maritime port inspection service. Arizona has a very effective service at her border ports and other states have good interior inspection systems but it is not our purpose in this paper to discuss any phase of plant quarantine work other than that done at maritime ports of entry and with particular reference to Florida.

Florida for many years, notwithstanding her tremendous horticultural interests labored under the handicap of an inadequate horticultural law. In fact, there was little or no law—and about the same amount of money with which to apply the provisions of the law. It required what was little less than a calamity, that is the introduction and spread of citrus canker, to arouse the fruit growers of Florida to the dangers to which they had been and were exposed. In 1915 the Legislature passed what is known as the Florida Plant Act of 1915. This law has since proven adequate in every respect and has been used as a model for similar laws enacted by several other State Legislatures. I may have

appeared to have digressed somewhat from the topic of my paper. As a matter of fact, however, I have just told you of the very foundation of a successful and efficient port quarantine service, a good law. Secondary to the good law is ample financial support. Realizing this, the Florida Legislature has made liberal appropriations for administering the provisions of the Plant Act.

With the bitter experience with citrus canker, an introduced disease, as an example, the State Plant Board determined that this disease should not again be introduced nor should other pests be brought in if possible to keep them out. Florida, owing to her peculiar geographical location, is exposed to attack by enemies from Central and South America and from the West Indies. Then too, owing to the subtropical nature of her climate, unwelcome visitors find a congenial home. Our task, therefore, was no light one. The State Plant Board, shortly after its organization created, under the direction of the Plant Commissioner, a port inspection service which beginning in a modest way has developed with age and experience. We now have inspection stations at all of the principal ports of entry in Florida, namely, Pensacola, Jacksonville, Miami, Key West and Tampa. Depending upon the volume of imports and passenger traffic, our force ranges from one to three men at each of these ports. I am frank in stating that this force is just about half the number really needed. These men are all trained and experienced inspectors who have seen service in other branches of Plant Board field service. Many of them have been educated as entomologists and plant pathologists, not all. In this connection, I would point out that in work of this nature, which after all is police or regulatory work, a high degree of technical training in entomology and pathology, while very desirable, is not essential. A knowledge of these subjects, such as may be gained by elementary courses or practical field experience is sufficient. In fact, some of our very best men have had no collegiate training whatever in entomology or plant pathology but these men as well as those who are technically trained *must* and *do* possess other qualifications which are of primary importance.

From the very nature of the work in which they are engaged our men encounter many difficult and trying situations. I am glad to say that invariably they have been able to overcome the difficulties and to handle unpleasant situations without an undue amount of friction. They have been courteous but firm, decisive but never offensively so, accommodating but not lax. The successful performance of the many duties devolving upon them calls for the employment of men of the very highest type. They must be men who can impress the public with the fact that they know their business and intend to attend to it. Being men of this

type they have been able to secure and hold the cooperation of Customs and transportation officials and that of commercial shippers. Without this cooperation their work would be seriously hampered if not made worthless.

As to the nature of the duties our men perform, it would be difficult to pen a picture graphic enough to give you a complete idea. The duties are multitudinous and comprehensive. All men holding appointments in the port quarantine service of the State Plant Board of Florida also hold appointments as collaborators of the Federal Horticultural Board, thus having to administer plant quarantine rules and regulations of both the federal and state governments. This arrangement is very advantageous, for as federal officials they possess certain authority and prestige not conferred through state appointment. The State Plant Board of Florida has, however, paid the salaries and borne all other expenses incident to the conduct of the work. There are some situations presented which are fully covered by federal rules, others by state rules and many by both state and federal measures. In the application of federal, as well as state regulations, it is necessary that the closest and most cordial relations shall exist between our men and the customs officials, for the reason that under the Federal Plant Quarantine Act of 1912, the application of the rules and regulations made by the Federal Horticultural Board is placed in the hands of the customs service. I mean, particularly, the matter of search of vessels, cargoes, baggage and passengers for materials coming under the provisions of the Act. Theoretically, therefore, plant quarantine inspectors are to act largely in an advisory capacity to the customs. In actual practice though, not only at Florida ports but in California and at such ports as have been opened as inspection stations by the Federal Horticultural Board, the plant inspectors really do make the search for contraband or regulated plant material and quite frequently assist customs officials in other ways. Sometimes it would be difficult for the casual observer to tell from the nature of the duties performed whether a man were a plant inspector or a customs inspector, so close is the cooperation and the interest of each in the work of the other. To a lesser degree, the same applies to our relations with officials of the immigration and public health services.

In their dual capacity our men, during the year ending April 30, 1920, boarded 4,500 vessels arriving at Florida ports. These have been inspected from stem to stern. Passengers' cabins and crews' quarters have been carefully searched. Every place where contraband plant material might be secreted has been investigated. Three hundred and fifty thousand parcels—baggage and commercial shipments—have been handled as being potential disease or insect pest carriers. Of this

number more than 4,000 have been refused entry as being dangerous. It is a common occurrence for our men to intercept material infected or infested with some disease or insect which is not now known to be present in this country and which if introduced would occasion great losses.

The question naturally arises as to the object and the net results of all this organization and the work done by it. It is hardly necessary for me to point out the object we seek to obtain. Horticultural history is replete with "horrible examples" of plant pest introductions in combating which the producer has paid a heavy toll for our neglect. We need not go far back for such examples, the gipsy and brown tail moths, San Jose scale, Japanese beetles, citrus canker, European corn borer, European potato wart, chestnut blight, white pine blister rust, Mexican boll weevil, Colorado potato beetle, pink bollworm; these are just a few. Florida and California have many insect pests and plant diseases which could have been kept out. The South Atlantic and Gulf States, as well as California, are particularly exposed to invasion by the Mediterranean fruit fly and other fruit flies. Europe, Africa and South and Central American and Oriental countries harbor plant enemies which must not be introduced into this country if our horticultural and agricultural industries are to continue to prosper. It is to keep these enemies out that California, Florida and the Federal Horticultural Board maintain their plant quarantine services and it is for the same reason that other coastal and border states should inaugurate similar services and that all states, coastal and interior, should see to it that the Federal Horticultural Board, through Congress, is supplied with ample funds for carrying on its work. It is to be regretted that the Board, through no fault of its own, has never since its creation been able to expand and develop its activities along the line of maritime port inspection to the extent which it undoubtedly desired and which it knew was necessary to afford the protection needed. I may be an enthusiast on this subject but I am of the opinion that the Congress should place at the disposal of the Federal Horticultural Board a quarter million dollars or more annually in order that all ports of importance can be properly safeguarded, this, too, irrespective of such efforts in the same direction as border and coastal states may make. I am of the further opinion that the very best results can only be secured by a continuation of the liberal policy of close cooperation between federal and state forces, such as is now in existence in California and Florida, with this difference, however, that the federal government should bear a greater portion of the financial burden than heretofore. After all, this matter of plant quarantine service is one of national concern rather than state or sectional.

As to the net results of our efforts in Florida, the following brief summary will perhaps serve:

During the period from May 1, 1919 to April 30, 1920, over 4,500 vessels arriving at Florida ports were boarded and inspected—2500 of these from foreign ports. In round figures 350,000 packages were handled during the year by our quarantine inspectors. Two thousand of these were returned to shippers—2,400 destroyed as dangerous.

Pests from 19 foreign countries or possessions were prevented entry during the year, the countries of origin as follows:

| | | |
|---|---|---|
| Argentine | Dominican Rep. | Japan |
| Bermuda | Ecuador | Jamaica |
| Bahamas | France | Nicaragua |
| Canary Islands | Grand Cayman | Mexico |
| Cuba | Haiti | Porto Rico |
| China | Isle of Pines | Panama |
| | | Spain |

One hundred and forty (140) different plant pests were discovered on importations, some of these pests not now known in this country. A number of these pests have occasioned great losses in the countries where they are established and would no doubt occasion as great or greater loss if introduced into the United States. Perhaps the most notable interceptions from the standpoint of potential danger were black fly, which has been intercepted on five occasions on material from Cuba and the Bahamas. Jamaica yam weevil, which occasions great damage to yams in Jamaica and other West Indian Islands, was found on a shipment of yams from Jamaica via Cuba. This weevil is not known to be present on the mainland and doubtless if introduced would occasion tremendous loss to the sweet potato crop. No less than eight serious insect pests not now known to be present in the United States were intercepted by our inspectors.

The Florida plant Board does not confine its protective efforts solely to inspection. Complete equipment for the fumigation of fruit and vegetable offerings from foreign countries are located at Key West and Port Tampa. Each of these chambers will accommodate 700 standard crates. During the active shipping season of the past summer and fall over 56,000 crates or barrels of fruits and vegetables from Cuba were treated. The treatment consists of hydrocyanic acid gas—1½ ounces of sodium cyanide per 100 cubic feet of space. No damage to fruit has been noted and no injury to consumers. The construction of these fumigating plants well illustrates the relations between ourselves and the transportation companies. When the necessity for treating shipments of fruits and vegetables, particularly from Cuba was pointed out to the carrying companies, together with out inability to provide suitable plants, the companies promptly undertook the construction and equipment of same.

The conclusion must not be drawn from the foregoing that the activities of the quarantine department of the State Plant Board are restricted to port inspection. Such is not the case. Our men are constantly on guard to prevent illegal movements of nursery stock, sweet potatoes, sugar cane and other products, both inter- and intra-state. Watch is kept over the various transportation agencies—express cars and sheds are inspected and freight yards and warehouses kept under observation. Various other important duties devolve upon our quarantine inspectors but the most important of all is the port inspection work.

No paper of this nature and presented at this time would be complete without some reference and tribute to the work of the Federal Horticultural Board and particularly of the Chairman, to whose efforts largely is due the fact that we now have on the statute books of the nation a plant quarantine law. For many years the Chairman contended for legislation unsuccessfully, but with indomitable will and bulldog tenacity refused to give up the fight; finally overcoming opposition and succeeding in having passed the Federal Plant Act of 1912. Since that time he and his associates on the Board have been untiring in their activities with corresponding accomplishments.

To sum up, I should say that the main factors contributing to successful quarantine work are:

1. A good law and reasonable rules.
2. Sufficient financial resources.
3. Competent men.
4. Co-operation and good will of commercial and transportation interests and of officials of the customs, immigration and other public services.
5. Application of the provisions of quarantine regulations in such a way as to afford the maximum amount of protection with the minimum amount of inconvenience to parties concerned and occasion the least interruption to commerce and traffic

These are the cardinal principles.

Chairman Sanders: It might have been better had we had Mr. Beattie's paper following Mr. Marlatt's address, but I think he has some important things to tell us at this time on "Operation of Quarantine 37."

# THE OPERATION OF QUARANTINE No. 37

By R. KENT BEATTIE, *Pathologist in Charge Foreign Plant Quarantines, Federal Horticultural Board, Washington, D. C.*

Quarantine 37 is the general nursery stock quarantine which, as supplemented by various special quarantines, now regulates the movement of plants and plant products into the United States. It became effective June 1, 1919.

Soon after this quarantine became effective the Federal Horticultural Board organized the Office of Foreign Plant Quarantines to handle the work connected with the operation of this and other foreign quarantines.

Plants and plant products enter the United States under the provisions either of Regulations 2, 3, or 14 of Quarantine 37. Regulation 2 permits the entry without restriction of field, vegetable and flower seeds and certain plant material imported for medicinal, food or manufacturing purposes.

Regulation 3 authorizes the entry under permit of certain bulbs, fruit and rose stocks, nuts, and seeds. The procedure under this regulation is in the main the same as that which previously obtained under the old nursery stock regulations. A permit, foreign inspection and certification, proper marking, and notices of shipment and arrival are required. With the exception of the bulbs the inspection is conducted as formerly by State inspectors acting as collaborators of the Federal Horticultural Board. The bringing under regulation of the great quantity of lily, lily of the valley, narcissus, hyacinth, tulip and crocus bulbs which annually enter the United States, presented a problem in inspection which the State inspectors were frequently not prepared to meet. Their funds had been secured and their forces organized on the basis of the inspection of fruit trees, ornamentals and their stocks. Fortunately bulbs are easily inspected at port of arrival. They require no machinery to repack. They are less likely to convey pests and pests are more easily detected upon them. In the case of those bulbs which enter the United States at the nine ports of arrival where the Federal Horticultural Board now maintains an inspection force, provision has, therefore, been made for the completion of their inspection and their release at the port of arrival.

## *Regulation 14*

Regulation 14 provides for the importation in limited quantities and under special safeguards of nursery stock and other plants and seeds not covered in Regulations 2 and 3 for the purpose of keeping the country supplied with new varieties and necessary propagating stock. Although the plants imported under Regulation 14 amount to about one per cent. only of those imported under Regulation 3, they represent a far greater

amount of care, study and interpretation of the regulations. Under Regulation 14 every case is a special case and requires special consideration. The first step in the procedure followed in the issuance of a special permit consists in the making of an application by the proposed importer. For this he uses form 207. He lists the varieties of plants which he wishes to import and furnishes the importation data. He furnishes information as to the plants he desires and their propagation. He certifies to the accuracy of the facts submitted and agrees to the conditions of entry. Essentially the application consists of (1) a list of varieties, (2) a statement of facts, and (3) an agreement.

The consideration of this application is undertaken by the Office of Foreign Plant Quarantines. The varieties requested are submitted to the Bureau of Plant Industry for consideration. The application is submitted to the chief of the Bureau who appoints a committee of experts to consider it. This committee makes recommendations to the Federal Horticultural Board as to the commercial availability of the varieties in the United States and the reasonableness of the quantity requested. This committee is furnished with any data on availability in the possession of the Office of Foreign Plant Quarantines in additon to the data possessed by the experts themselves. The findings of the Bureau of Plant Industry Committee are submitted to and approved by the Chief of the Bureau of Plant Industry, himself a noted horticulturist, before they are returned to the Board. The records as to the recommendations of the Bureau of Plant Industry experts are kept in the office of Foreign Plant Quarantines. Since many varieties are requested again and again by different importers, in many cases no new decisions are involved and no consultation is necessary. For instance, 89 different special permits, issued between June 1, 1919, and December 10, 1920, included the new Dutch variety of gladiolus called Le Marschal Foch.

In determining what varieties are or are not available in the United States in quantities sufficient for propagating purposes the policy of the Federal Horticultural Board has been to be liberal. A liberal policy has also been followed in regard to the quantities permitted import. It has been felt that if a variety is not available here and it is to be established here the sooner the introduction is accomplished and we can rely upon American production the less dangerous is the importation. The introduction of small quantities from various localities over a series of years multiplies the danger.

In the consideration of an application it is necessary also to consider the purpose of the importation. Importations under Regulation 14 are

permitted for the purpose only of keeping the country supplied with new varieties and necessary propagating stock. They are not permitted for immediate commercial distribution or for the mere ornamentation of private estates. Special permits are issued to commercial propagators, to amateur propagators and to botanical gardens. The value of the amateur fancier and student of plants and the grower of a special collection to the development of American Horticulture is recognized by the regulations. Every effort is made to discriminate fairly between such cases and those where plants are desired merely as ornaments. Among the most difficult cases to handle are those where plants are desired merely for sentimental reasons: roses from the old home in England, plants from the battlefields of France, dwarf Japanese trees in the baggage of tourists, and so on ad infinitum. It is manifest that such applications usually fall without the limitations of the quarantine and cannot be authorized.

During all this consideration the bearing on the case of some 40 odd special quarantines and restrictive orders such as the citrus quarantine must be kept in mind.

When the application is granted a bond is prepared and sent to the permittee with his copy of the permit. This bond he executes and returns to the Board. He is bonded in the sum of twice the estimated value of the shipment to live up to his agreement with the Board. In a great many cases such a bond is unnecessary, but a few plant growers must be forced to comply with their agreements, and it is impossible to discriminate between individuals in the enforcement of the quarantine. Public institutions such as botanical gardens are, however, not required to furnish the bond.

When the plants come from abroad and reach the port of first arrival—which is usually New York—they follow the usual nursery stock course. The importer or his representative files with the customs authorities the usual customs papers accompanied by a notice of arrival and a notice of shipment and asks for customs authority for immediate transportation of the plants to the port of entry (Washington or San Francisco, as may have been specified). The notice of arrival and shipment are turned over to the Federal Horticultural Board inspectors by the Customs authorities. On that same day, or if the papers come in late in the day, on the next day, the material is located on the piers and examined to see:

(1) If it complies with the Regulations as to certification and markings, and

(2) If it is free from sand, soil, and earth, and is not obviously infected or infested.

A few boxes at random are opened, but only a very small portion of the material is examined. If passed, the immediate transportation customs papers are signed by our inspector and the movement of the material to Washington or, if on the Pacific coast, San Francisco is authorized.

Delay at the port of arrival or in transit is never due to our inspection. Thus far, all of the special permit material has arrived at New York, San Francisco, or Seattle. At each of these three ports we have an adequate inspection force of competent men. Delay is usually due to:

(1) A lack of knowledge of customs procedure on the part of the importer and a consequent failure to provide for the services of a broker to get track of the goods when they arrive and to make proper customs entry.

(2) Dilatoriness on the part of brokers and transportation companies.

If Washington is the designated port of entry, the material arrives at that port in a customs bonded car and is hauled immediately to our Inspection House by a customs bonded transfer company. Our Inspection House has the status of a customs bonded warehouse. The material is inspected at once. If it is free from pests and the requirements have been complied with, the Collector of Customs is notified and the material is released. Small packages are shipped out at once by our own men in accordance with the instructions of the importer. If the shipment is a large one, it is turned over to the importer's customs broker for handling.

Shipments arriving at San Francisco intended for Pacific Coast points are inspected and released there. In spite of the wild statements frequently issued, no shipment has ever crossed the continent to be inspected at Washington and returned to the Pacific Coast.

After arrival at destination the plants are grown and propagated by the importer at the designated place for a period of one to five years, as specified in the bond. The length of time specified depends upon the nature of the plants. Gladiolus bulbs, for example, are bonded for two years; bulblets for three; orchids for five.

As far as is possible, each lot of material is visited annually during the growing season by an inspector of the Federal Horticultural Board and reinspected under field conditions.

In the 18⅓ months in which the quarantine has been in operation up to December 10, 1920, 554 special permits have been issued to 273 different permittees. The material imported under these permits is being grown or will be grown in or near 214 different towns in 32 different states.

CHAIRMAN SANDERS: Mr. Stockwell is not here to present his paper on "The Japanese Beetle Quarantine," but we have his paper. Mr. Sasscer asks that his paper on "Important Foreign Insect Pests Collected on Imported Nursery Stock in 1920," be eliminated.

The next thing is the transaction of business, the first item being the report of the Nominating Committee.

MR. DIETZ: Your Committee on Nominations wishes to propose the following names for officers of this Section during the ensuing year:

Chairman of the Horticultural Section and Third Vice-President of the American Association of Economic Entomologists: Prof. A. G. Ruggles, St. Paul, Minnesota.

For Secretary, Mr. E. R. Sasscer of the Federal Horticultural Board of Washington, D. C., who has shown his ability to give us one of the most interesting programs the Section has had for several years.

MR. COTTON: I move that the report be adopted, that we approve the selection, and the names be referred to the Association for election.

The motion was duly seconded and carried.

Adjournment.

## Joint Meeting

## American Association of Economic Entomologists and American Phytopathological Society

*Friday Morning, December 31, 1920*

The joint meeting of the American Association of Economic Entomologists and the American Phytopathological Society was held Friday morning, December 31, 1920, at the University of Chicago.

It was called to order at 10.30 a. m. by President Wilmon Newell of the former association.

PRESIDENT WILMON NEWELL: This meeting is the result of an invitation extended to the American Phytopathological Society by the American Association of Economic Entomologists which was most graciously accepted by the former society.

As entomologists we are very glad that the Phytopathologists accepted our invitation, as this means a great deal to us and it is an indication of progress. It is also a confirmation of our belief that the two societies entertain for each other that friendship and spirit of cooperation which is invariably shown between Phytopathologists and Entomologists as individuals. It is appropriate that the president of the visiting society should preside over our deliberations this morning. He needs no intro-

duction to the plant pathologists, who are familiar with his many scientific achievements. Some of the members of the American Association of Economic Entomologists, however, may not be so fortunate as to know Dr. Orton personally, and to them I take pleasure in introducing Dr. W. A. Orton, President of the American Phytopathological Society who will preside this morning.

President W. A. Orton: As retiring president of the Phytopathological Society, I wish to express our appreciation of the invitation from the Entomologists which has brought us together today and to express our convictions that such meetings ought to come more frequently. Perhaps they should have come earlier. It has even been suggested that we in this country have made a mistake in developing two branches of plant pest study and control separately and independently of each other. At any rate, each passing year reveals new points of contact.

We shall discuss today only one phase of the problem of control wherein similar methods are used to combat both insects and diseases. "A Symposium on Dusting as a Means of Controlling Injurious Insects and Plant Diseases" is to be presented.

The first paper will be given by Mr. P. J. Parrott, Geneva, N. Y.

## CONTROL OF SUCKING INSECTS WITH DUST MIXTURES[1]

By P. J. Parrott, *Geneva, N. Y.*

The efficient protection of bush and tree fruits involves several factors—the prevention and control of plant diseases, the repression of leaf- and fruit-eating insects, and the destruction of certain haustellate species which are commonly classified as scales, aphids, capsids, etc. It is self-evident that no system aiming to afford protection to fruit plantings satisfactorily meets practical necessities which does not secure adequate control of all three categories of parasites. In considering the merits of dusting as related to orchard management in New York, there has been a great lack of experimental data regarding the value of dusting in combating such insects as San Jose scale, blister mite, green apple aphis, rosy aphis, leafhoppers and redbugs. Although apple scab and codling moth usually levy the largest tribute, the shrinkage in yields due to attacks of sucking insects is by no means insignificant and during some seasons the accumulative losses reach impressive proportions. Certainly, no grower in this state is properly conducting

[1]Condensed from a paper presented to the joint meeting of the Association and the American Phytopathological Society at Chicago, Dec. 31, 1920. Typical tests have been selected to illustrate the nature of the investigation and the average results secured.

his orchard operations who fails to make provisions for the control of these pests. Likewise, the neglect of pear psylla, thrips, or the green bug is likely to be attended with serious consequences as is usually manifested by the reduced yields and impaired vitality of the trees. Similar considerations hold true for the grape leafhopper, the currant aphis and four-lined plant-bug, the potato aphis and leafhopper, and the onion thrips. In view of the importance of this class of insects and of the need for information as to their susceptibility to dusting preparations, the Geneva Station began a serious investigation of the problems during the past season. My contribution to this symposium, therefore, deals largely with the more important results of this inquiry.

## Tests with Various Fruit Insects

A series of experiments are here described which were designed to ascertain the effectiveness of dusting mixtures on a number of common sucking insects. The objects which we hope to attain, and which we succeeded in attaining in part, were: (1), Data on the susceptibility of various insects to dusting preparations with definite ratios of nicotine; (2), some knowledge of the efficiency of dusting for the control of certain species under field conditions; and (3), information as to the importance of accessory factors in the effectiveness of dusting operations.

## Conditions of the Tests

The following species of insects were used in the experiments: The green apple aphis (*A. pomi* De Geer), the rosy aphis (*A. sorbi* Kalt.), the grain aphis (*A. avenæ* Fab.), the apple leafhoppers (*E. rosæ* L. and *E. unicolor* Gillette), the apple redbug (*Lygidea mendax* Reuter), the pear psylla (*Psylla pyricola* Forster), the currant aphis (*Myzus ribis* L.), the four-lined leaf-bug (*Poecilocapsus lineatus* Fab.), and the potato aphis (*M. solanifolii* Ash.) The dusting preparations were applied with "hand dusters," "hand blowers," or orchard power outfits. A mixture of superfine sulfur, 90 percent. and powdered lead arsenate, 10 percent. was the carrier of the nicotine. In many of the experiments provision was also made for application of liquid insecticides at standard strengths.

## Susceptibility of Insects to Dusting Preparations

### *The Apple Redbug*

Experiments with apple redbugs were conducted on June 1 and 2 in an 18-year-old orchard composed chiefly of such varieties as Greening, Hubbardston and Baldwin. This planting had suffered serious injuries for successive years, and at the time of the test over 90 percent. of the

terminal growth of many of the trees was damaged. In Plat I ten Greening trees were dusted with a preparation containing 0.5 percent. nicotine. A little more than fifty pounds of dust were applied and one tree (Tree 1) was very thoroughly dusted. In Plat II seventeen Greening trees were dusted, using from eighty-five to ninety pounds of material. One Greening tree (Tree 2) was given an application of two and one-half gallons of lime-sulfur diluted with one hundred gallons of water to which was added one pint of nicotine sulfate. To insure thorough treatment, twenty-three gallons of the mixture were applied. In the treatment of the individual trees much care was exercised to make thorough applications without any attempt to economize on materials. Fumigation sheets were spread on the ground beneath each tree in order that the redbugs could be collected as they fell. After the first count the trees were shaken quite violently at repeated intervals and after each operation the condition of the insects, whether dead or alive, recorded. The effectiveness of the different treatments is indicated in Tables I and II.

TABLE I—EFFECTS OF DUSTING ON REDBUGS

| Condition of Insects | Tree 1 Dusted | Tree 2 L. S. and Nicotine Sulfate | Tree 4 Check |
|---|---|---|---|
| Dead | 437 | 594 | 14 |
| Living | 132 | 36 | 317 |
| Total | 569 | 630 | 331 |
| Percent. living | 23.2 | 5.7 | 96.7 |

TABLE II—INFLUENCE OF DUSTING FOR REDBUGS IN PREVENTING INJURIES TO FRUITS

| Treatment | No. of Apples | No. Apples Injured | Percent. Injured | |
|---|---|---|---|---|
| Dust, 0.5 percent. nicotine | 717 | 41 | 5.7 | Average |
| | 1682 | 84 | 4.9 | 5.3 |
| Dust, 1.0 percent. nicotine | 1349 | 201 | 14.9 | |
| | 2280 | 198 | 8.6 | |
| | 595 | 26 | 4.4 | |
| | 2857 | 149 | 5.2 | |
| | 1266 | 72 | 5.7 | 7.4 |
| Lime-sulfur and nicotine | 1228 | 15 | 1.2 | |
| Check | 1120 | 997 | 89.0 | |

Redbugs proved very sensitive to nicotine, dusting preparations carrying this ingredient producing almost instant paralysis upon coming in contact with the insects. No difference in rapidity of action or in effectiveness was discerned between the dusting preparations which contained respectively 0.5 and 1.0 percent. nicotine.

## *The Apple Aphids*

The conditions under which the experiments with aphids were carried out may be briefly described as follows: Apple buds infested with newly hatched nymphs of *avenæ*, *pomi* and *sorbi*, principally the former species,

were thoroughly dusted with preparations containing 0.5, 1.0 and 2.0 percent. nicotine. As previous experiments had indicated that there was very little difference between the three species with regard to their susceptibility to the dust, and since the majority of the nymphs belonged to *avenæ*, the counts were made without any attempt to distinguish the different species. The effects of the dusting on the aphids are given in Table III.

TABLE III—RESULTS OF DUSTING AGAINST APPLE APHIDS

| Treatment | No. of Buds | Original No. of Aphids | Average No. Aphids per Bud | Percent. dead after 4 Days |
|---|---|---|---|---|
| Dust 0.5 percent. nicotine | 40 | 121 | 3.02 | 91.7 |
| Dust 0.5 percent. nicotine | 32 | 80 | 2.5 | 98.7 |
| Check | 32 | 81 | 2.56 | 27.1 |
| Check | 17 | 38 | 2.2 | 65.5 |
| Dust, 1 percent. nicotine | 37 | 89 | 2.4 | 87.6 |
| Dust, 2 percent. nicotine | 50 | 107 | 2.14 | 97.2 |
| Check | 18 | 42 | 2.3 | 47.8 |
| Dust, air-slacked lime | 53 | 127 | 2.4 | 78.6 |
| Lime-sulfur and nicotine | 58 | 120 | 2.03 | 97.5 |
| Check | 14 | 25 | 1.78 | 60.0 |

At the time of the opening of the apple buds the extent of infestation by aphids may be greatly influenced by such factors as driving rains, sleet storms, high winds and low temperatures. The reduction in the number of insects on the checks by natural means was considerable in some instances, and it is reasonable to suppose that similar influences operated on the sprayed and dusted series. A study of the data shows that, on the whole, dusting compared quite favorably with spraying in insecticidal efficiency. It should also be noted that a heavy application of air-slaked lime resulted in a loss of 78.6 percent. of the aphids.

One of the interesting results of the season's activities with aphids is that different species are apparently not equally susceptible to dust mixtures with the same nicotine content. The fact that some aphids are more resistant than others was most clearly demonstrated in some tests with *M. solanifolii* and *S. lanigera*, which proved very much less susceptible to treatment than the common apple species, such as *pomi*, *avenæ* or *sorbi*.

*The Apple and Grape Leafhoppers*

In the experiments against the apple redbugs, to which attention has previously been called, the nymphs of *Empoasca unicolor* and *Empoa rosæ* proved very susceptible to dust mixtures containing 0.5 and 1.0 percent. nicotine and fell completely paralyzed in large numbers on the collecting sheets. As the control of these species was not contemplated when the work was undertaken, no attempt was made to determine the effectiveness of the treatment in protecting apple trees.

In an experiment with grapes, an application of dehydrated copper sulfate and lime containing 2.0 percent. nicotine destroyed eighty percent. of the nymphs of the leafhopper.

Since the foregoing species are apparently quite vulnerable, a problem deserving serious attention is the value of this system of treatment in combating such insects in commercial plantings of apple and grape.

### *The Pear Psylla*

During the past summer a special effort was made to ascertain the comparative effectiveness of various spraying mixtures and dusting preparations in controlling psylla nymphs. As the results, in general, were quite similar one experiment is selected as typical. On June 3, 1920, a plat of thirty Bartlett trees, about fifteen years old, was sprayed with bordeaux mixture (4–4–100) to which was added 6 pounds of paste lead arsenate and 1 pint nicotine sulfate. Four gallons were applied on the average to each tree. An adjoining plat of sixty trees of the same variety was dusted on the following day with a mixture composed of 50 pounds sulfur, 10 pounds lead arsenate, 5 pounds nicotine sulfate, and 30 pounds powdered tobacco. About 2⅔ pounds were applied on the average to each tree. Before treatment the nymphs on fifty tagged spurs on each plat were counted, and on the day following the operation each of these spurs was re-examined and the nymphs present recorded. The data are given in Table V.

TABLE V—COMPARATIVE EFFECTIVENESS OF SPRAYING AND DUSTING AGAINST PSYLLA NYMPHS

| Material | Nymphs per Spur before Treatment | Nymphs per Spur After Treatment | Nymphs Killed |
|---|---|---|---|
| | No. | No. | Percent. |
| Bordeaux mixture and nicotine sulfate | 42.57 | 0.30 | 99.4 |
| Sulfur and nicotine sulfate | 41.58 | 15.92 | 61.7 |

In this experiment, as with other similar efforts, the dust mixture killed a goodly percentage of nymphs; but, as compared with spraying, the treatment proved considerably less effective. The nymphs secreted in the axils of the leaves and fruits and, heavily coated with honey dew, displayed the greatest resistance. It was under such conditions that the inferiority of dusting to spraying was most marked.

In experiments with hibernating adults, spraying proved very much superior to dust mixtures as measured by the number of adults dislodged from the trees and the percentage killed by the treatment.

### *The Currant Aphis and Four-Lined Bug*

Mixtures containing 0.5 and 2.0 percent. nicotine produced complete paralysis of currant aphids. With the opening of currant buds it became increasingly difficult to do effective dusting because of the interference of the dense foliage.

Nymphs of the four-lined bug proved very much more resistant to nicotine than the apple redbug or certain species of aphids. Preparations containing 2.0 percent. nicotine caused paralysis, from which none recovered. As with the aphids, dense foliage produced by the new growth made it very difficult to secure effective control by dusting.

## Principal Findings and Discussion of Results

Dusting mixtures containing nicotine were toxic to aphids, redbug, leafhoppers of the apple, the currant aphis and four-lined plant-bug.

The degree of susceptibility to dusting preparations varied with different species. Mixtures with 0.5 percent. nicotine were fatal to the apple aphis and redbug and to the currant aphis. Preparations at this strength also reduced nymphs of the four-lined plant-bug to a state of inactivity, although the insects ultimately recovered with few fatalities. Dusting with mixtures containing 2.0 percent. nicotine was fatal to the nymphs. Mixtures containing less than 2.0 percent. nicotine gave very poor control of the potato aphis. The nymphs of the pear psylla displayed considerable resistance to preparations containing from 0.5 to 2.0 percent. nicotine. Mixtures with 0.5 percent. nicotine destroyed only a small percentage of hibernating adults, and preparations with 1.0 percent. nicotine were less effective than spraying mixtures composed of nicotine sulfate and soap in the usual proportions.

Air currents, denseness of tree growth, low temperatures and exudates of insects, such as wax and honeydew, exerted a greater adverse influence on the efficiency of dusting preparations than on that of spraying mixtures. These results suggest that while certain principles of procedure apply equally well to both systems of orchard treatment, the field technique required for effective dusting differs in important particulars from standard spraying practices. In its present stage of development dusting displays defects both as to methods of application and machinery which will probably be overcome by the corrective processes of experience. A study of present dusting methods shows also that a distinction should be made between obvious limitations of dusting materials and machinery and failures which arise from attempting to dust under conditons that are unfavorable for effective work. In the foregoing experiments operations which proved promising when no breeze was stirring and when the trees had open tops would not infrequently yield quite different results when strong air currents prevailed and the tree growth was dense. The inefficiency of dusting was most marked with the pear psylla and the woolly aphis, as the honey dew and waxy secretions of these insects were repellent to the materials. It was also noted that during periods of low temperature dusting was less effective than when high temperatures prevailed.

Our experiments show clearly that, while dusting has possibilities, it is not wise with our present knowledge and experience to encourage too great expectations as to the practicability of combating common sucking insects by this system of treatment. Growers who possess dusting machinery and do not consider present prices for contact insecticides prohibitive, might well conduct an experiment against the apple redbug. To attempt very large operations against other species of sucking insects would expose the growers to the risk of great expenditures for materials and large losses in fruit yields through inefficient control.

If the data make one point clear it is that dusting for sucking insects is in its first phase. While many failures have been noted in our experiments, we should be ignoring the history of scientific progress if we relied too much on early negative indications. The conservative as well as the constructive view to take is that conditions have passed the stage where dusting is considered wholly impracticable to one where it may be regarded as having possibilities under certain conditions. It remains to be seen whether this system of treatment will enter the realm of practical fulfillment of all the requirements and needs of the commercial orchard. It will take time and money, but it is well worth doing and needs to be taken up by those with special aptitude and necessary funds and equipment.

### *Improvements in Machine Construction*

The conspicuous results obtained by dusting are speed of operation and economy in labor. It is presumed that dusting machinery is in the experimental stage and, if so, improvements will unquestionably be made that will meet the requirements of different field crops and various bush and tree fruits. It is also not unreasonable to hope that for the treatment of large trees outfits will be available which will insure satisfactory distribution of materials without sacrificing speed.

With such pests as redbugs and aphids, effective results will depend on the thorough coating of the insects. In dusting large trees it has been difficult to obtain satisfactory control without incurring large expense for dosage, which appears excessive in comparison with the cost of labor or for like materials used in spraying. In considering the items that enter into this expense, the fact stands out clearly that contact insecticides in powder form now prepared and sold by commercial companies are expensive and almost prohibitive for large operations. On the other hand, with existing types of orchard dusting outfits there is danger of applying excessive amounts to insure thorough treatment, and every pound in excess of actual requirements for effective work multiplies rapidly the cost of the operation. It is evident, then, that

while seeking to reduce the cost of insecticides encouragement should also be given to improving machinery which will insure both thorough and economical distribution and thus produce maximum benefits with minimum dosage. I merely wish to emphasize the practical bearing of this phase of the problem. I have not attempted to suggest modifications, but the improvement of machinery to meet the requirements of different crops needs serious attention.

### *Chemical Assistance in the Investigation of Dust Mixtures*

In considering materials for dusting to combat such insects as aphids, capsids, etc., it should be noted that there is not a wide range of available substances with desirable insecticidal properties. At present nicotine sulfate is widely used, and is certainly the most effective constituent of dust mixtures which function as contact insecticides. A serious drawback to its extensive employment for this purpose is its high cost, and besides it has not always been available in sufficient quantities for commercial operations. The situation reveals a great need of more knowledge concerning the insecticidal properties of other substances, as there are doubtless various organic compounds equal to nicotine in value.

What is true of organic substances holds equally well with inorganic compounds. There is probably a large range of chemical agents which could be prepared in commercial quantities as soon as their properties are known and a need created for them.

Mention is made of these facts in order to focus attention on the promising field that awaits investigation and to emphasize the great need of cooperation between entomologists and chemists. Entomology is greatly handicapped by a lack of chemical assistance. In plans for the development of efficient dusting preparations it is not sufficient to have expert assistance in the quest for new insecticides only. It is also highly important to have technical knowledge relative to the physical condition of the materials used and of the influence of the physical properties on the effectiveness of the substance as an insecticide, since this is dependent upon factors other than its mere chemical composition. The difficulties that beset the dusting problem plead loudly for more constructive efforts along these lines and for a sharpening of the weapons of the entomologist.

## Conclusion

In conclusion, this symposium, attracting as it does workers from the fields of phytopathology and entomology, constitutes a significant step, probably more important than is generally realized. The discussions should bring up new points of view and yield keener analyses of methods

and policies, and to that extent should promote a sane solution of the problem of dusting for the control and suppression of crop pests. The task is admittedly not a simple one. It is the usual experience, however, that difficulties lessen as we approach them with open minds, show a disposition to be fair, and a determination to reach the result which the facts rather than our predilections require. The collection and tabulation of existing experimental data will form the foundation upon which subsequent progress will be built. We may hope, therefore, that the future will bring order out of the chaos of conflicting opinions which exist with respect to a large field of significant data. The program may seem ambitious, but responsibility for action largely rests with the scientific workers in the two branches of effort. Ours is the task to create a stimulus and arouse an interest which shall bear fruit in practical endeavor.

President W. A. Orton: Mr. T. J. Headlee will now discuss his experiences with Dusting to control Sucking and Biting Insects, with special reference to the plum curculio and the codling moth.

## DUSTING AS A MEANS OF CONTROLLING INJURIOUS INSECTS[1]

By Thomas J. Headlee, Ph.D., *New Brunswick, N. J.*

Late in the year 1912 the writer reached the conclusion that the development of powdered arsenate of lead and of finely divided sulfur had reached a point where further experiments on the relative value of dusts and sprays for control of insects injurious to apple and peach should be undertaken. In cooperation with Mr. F. H. Pough of the Union Sulfur Company and Mr. C. D. Vreeland of the Vreeland Chemical Company, a plan for attacking this problem was worked out and at the Cleveland Meetings of this society this plan was gone over and modified by Mr. F. M. Blodgett, Dr. Reddick and Dr. Whetzel of the Cornell Agricultural Experiment Station. This plan involved similar tests in certain of the Experiment Stations of the United States east of the Rocky Mountains, selected from the standpoint of the fruit growing industry. This plan included a test of a dust composed of finely divided sulfur and powdered arsenate of lead as compared with the same materials delivered in suspension in water and as compared with the standard commercial liquid treatments for the crop in question. The idea of

[1]Paper 18 of the Technical Series, N. J. Agricultural Experiment Stations, Department of Entomology.

delivering the same materials used for dust in a water suspension was carried out in New Jersey fully only the first year.

An experiment on apple and another on peach was undertaken at Glassboro and still another on peach at Vineland. The difference between the experiments at Glassboro and at Vineland lay in the fact that at Glassboro an effort was made to maintain a coating of the dust throughout the period of insect attack, while at Vineland no more applications of dust were made than were made of liquid spray. On peach both at Glassboro and at Vineland excellent control of both diseases and insects was obtained, but the foliage in both instances was so severely burned that the fruit never reached a satisfactory size.

In 1914 tests were again undertaken on peach at Vineland and on apple at Cranbury. Again the control obtained by dust on peach at Vineland was excellent, but the damage done to the foliage was so severe as to prevent the fruit from reaching proper size for market.

By 1917 a corrective for foliage injury, due to this dust mixture, had been found in the form of hydrated lime. The Horticultural Department of the Station undertook an extensive test of the relative value of sulfo-arsenical lime dusts and self-boiled lime sulfur-arsenate of lead liquid sprays. The control of insects and diseases obtained in all three years of experiments and the freedom from injury found in 1917 was such as to make the New Jersey Station feel that further tests of this material upon peach were unnecessary. The sulfo-arsenical lime dusts have been recommended since that year as practically equivalent in efficiency to the self-boiled lime sulfur arsenate of lead liquid sprays.

The data relative to the efficiency of the sulfo-arsenical lime dusts as compared with the liquid treatments on peach are set forth in the following table:

| Year | Location | Sound Fruit Percent. | Curculio Percent. | | | Scab Percent. | | |
|---|---|---|---|---|---|---|---|---|
| | | | Check | Dust | Liquid | Check | Dust | Liquid |
| 1913 | Glassboro .... | | 29.1 | 4.4 | 5.5 | 22.2 | 0.0 | 0.0 |
| 1913 | Vineland ... | | 70.3 | 43.3 | 31.6 | 51.9 | 14.8 | 6.4 |
| 1914 | Vineland .... | | | 3.68 | 3.88 | | 3.86 | 19.69 |
| 1917 | Haddonfield . | | no rec | ord | | 57.83 | 5.05 | 2.52 |
| Average | ............. | | 49.7 | 17.12 | 13.66 | 43.97 | 7.90 | 9.53 |

On apple the results have been very different from those on peach and the New Jersey Station has not ever and is not now ready to recommend the sulfo-arsenical dusts as in any way equivalent to the liquid sprays in efficiency in control of insects injurious to that crop.

In 1919 the New Jersey Station undertook a set of experiments in an orchard very severely infested with codling moth and curculio. The blocks were laid out by the Acting Horticulturist and the Entomologist. The materials were applied by the orchardist with his own organization

and the data were taken on the picked fruit only by the entomologist in cooperation with the acting horticulturist and the plant pathologist. No checks were left in this set of experiments.

In 1920 a plan of further testing the relative efficiency of the sulfo-arsenical dusts and liquid sprays was prepared in conference with Mr. P. J. Parrott, Mr. C. R. Crosby, Dr. W. E. Britton, Mr. H. E. Hodgkiss, Mr. S. W. Frost and the writer. It was proposed that tests according to this plan should be placed in Connecticut, New York, Pennsylvania and New Jersey. The Entomologist enlisted the cooperation of the Acting Horticulturist and the Plant Pathologist of the New Jersey Station. The apple blocks were located near Moorestown. The applications were made by the Acting Horticulturist and the Entomologist. The data were taken by the Plant Pathologist and the Entomologist. The following table will serve to set forth the results obtained from the 1913, 1914, 1919 and 1920 experiments.

| Year | No. of Expts. | Location | Sound Fruit | | | Curculio | | | Codling Moth Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | D | S | C | D | S | C | D | S |
| 1913 | 1 | Glassboro ....... | | | | | | | | | |
| 1914 | 1 | Cranbury ....... | | | | | | | 4.7 | 4.1 | 2.7 |
| 1919 | 1 | Moorestown .... | | | | | 20. | 9.5 | | 65. | 30.3 |
| 1920 | 1 | Moorestown .... | 58.5 | 73.7 | 97.45 | 28.3 | 19.8 | 7.1 | 11.6 | 8.8 | 4.1 |

| | Codling Moth | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | First Brood | | | Second Brood | | | Scab | | | Legend |
| | C | D | S | C | D | S | C | D | S | C = Check |
| 1913 ............ | | | | | | | 68.6 | 46.4 | 36.4 | D = Dust |
| 1914 ............ | | | | | | | 33. | 14.1 | 16.8 | S = Spray |
| 1919 ............ | | 15 | 7.4 | | 50 | 22.9 | | 22. | 61.4 | |
| 1920 ............ | 4.2 | 1.4 | 1.5 | 7.4 | 7.7 | 2.5 | 3.7 | 2. | 1.5 | |

Examination of this table shows that in the 1913 tests no data on either curculio or codling moth were obtained because there was not enough of either insect to give results. In 1914 the curculio was not sufficiently abundant to give data and the codling moth on the untreated trees attack only 4.7 percent. of the total fruit.

In 1919, however, there was an abundance of both codling moth and curculio and in 1920 the curculio was present in large numbers and the codling moth in fair numbers.

Examination of the data, as set forth in this table indicates at once that the control of codling moth and curculio obtained by the use of the sulfo-arsenical dusts could not compare with the results obtained by the liquid sprays.

In view of the fact that Professor Whetzel, in his address to the New York State Horticultural Society at Rochester last year, presented large accumulations of data from Nova Scotia, New York, Michigan and Illinois in which he showed that the control of codling moth obtained by

use of the dust was, at least, as good as that obtained by liquid sprays, the writer has given considerable thought to the possible reason for the wide difference in the findings as reported by Professor Whetzel and the facts as derived from the New Jersey experience.

The fact that the codling moth in Nova Scotia, New York and Michigan shows either one brood or one and a partial second may have a good deal to do with the apparently better results obtained with dust in these areas, because the period during which the fruit must be protected is scarcely more than one-half of the time during which the fruit must be protected in New Jersey where two full broods of that insect are developed, but this will not hold in making comparisons of results obtained in Illinois, for in that state there are also two full broods of the codling moth.

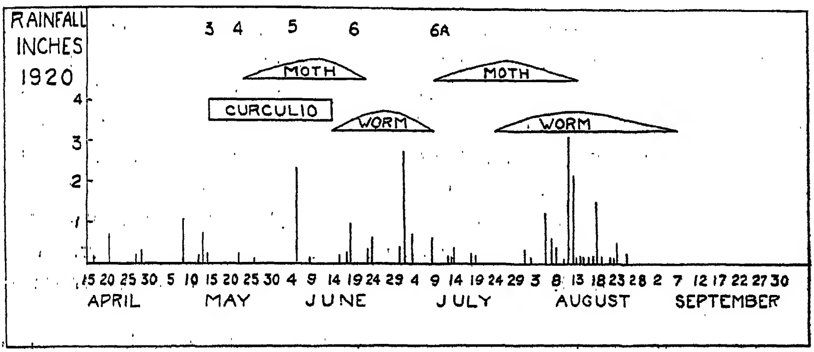


Fig. 4. Chart showing relation between rainfall, the occurrence of the codling moth and curculio and the time of spraying.

In Illinois, however, the normal annual rainfall is about 10 inches less than it is in New Jersey and theoretically the washing to which the dust applications would be subjected in that state would be materially less than that to which they would be subjected in New Jersey. The total rainfall in any year, or in any month is not a really trustworthy guide to the effect of the same upon the efficiency of dust applied mixtures, except insofar as the same indicates that the distribution during the dusting period is such as promptly to wash off the applications. In studying the effects of rainfall it is, therefore, necessary to study the distribution of daily precipitation during the periods when the dust must protect the fruit from the attacks of the codling moth.

Such a study has been made under New Jersey conditions for the year 1920. The season started late that year and the emergence of the first brood of moths and the entrance by the larvae covered materially shorter periods than in 1919. An average of 2.8 pounds of dust were

given to every tree in the dusted blocks on June 19 just after worm entrance began. This application experienced only three rainfalls until July 1st. The first of these three rainfalls was about .25 of an inch, the second was about .51 of an inch and the third was .4 of an inch. Furthermore this application of dust was made the day following a rainfall of .75 and this may have something to do with causing the dust to stick to the foliage more effectively than if applied during a dry period. Furthermore, it is probable that the period of entry being bunched because of the lateness of the season had largely occurred by July 1st, when a rain of 2¾ inches fell completely removing the dust from the trees. Under these conditions, the control obtained with the dust was as good as that obtained with the spray.

On July 9th the trees in the dusted block received an average of two pounds each and those in the sprayed block 7.5 gallons each. This spray was applied according to schedule and as can be seen from consulting the chart occurred much earlier than it should have. As a matter of fact, application 6 A should have been given about July 24th. Following this application of July 9th there were seven rains preceding August 6th when a rain of 1.1 inches fell followed at very frequent intervals by rains of considerable size, one of which amounted to 3.1 inches. The entrance of side worms began about July 25th and 26th and from that date on to August 6th, a matter of 11 days, it is fair to assume that the dust was still on the trees in sufficient quantities to be an effective factor in control.

From August 6th on to near the end of the month, a period of about 25 days, it is fair to assume, in view of the rainfall, that the dusted trees were practically unprotected. As a matter of fact, the dust exerted less than one-half as much control of the codling moth of the second brood as did the spray.

Thus there appears a definite relation between the effects of the dust and the distribution of the rainfall. It is also evident that the only way in which the effect of rainfall can be evaluated is to know not only the daily distribution of rainfall, but its daily distribution in relation to the period covered by entry of the codling moth worms of the first and second broods.

No data with which the writer is familiar has shown decidedly as satisfactory a control of the plum curculio on apple as has the liquid spray, but the amount of data available on control of this insect by dust applications on apple, taking the country as a whole, is decidedly limited. There is no reason, known to the writer, to indicate that the effect of rainfall on dust applications for codling moth will not apply with equal force to dust applications for curculio. This relative ineffectiveness

of the dust for control of curculio is certainly true under the average New Jersey experience, not only on apple, but also to a less extent on peach.

If the rainfall is, as it seems to be, a limiting factor in the effectiveness of dust applications as they are at present made, and if distribution of rainfall is such as to minimize the effect of dust applications by washing them from the tree, the writer thinks it entirely fair to conclude that the dust applications for control of curculio and codling moth are not as certain to give good results even in territories of low rainfall (for even in such areas the distribution may in any year wash off the dust at critical times )as are liquid sprays.

Speaking from the standpoint of peach growing in New Jersey, the writer wishes to say that he regards the sulfo-arsenical lime dusts as nearly equivalent to the self-boiled lime sulfur arsenate of lead liquid sprays, but that in dealing with apple growing he regards the sulfo-arsenical dusts as not comparable in efficiency with the liquid sprays and that he can recommend them only as an adjunct where for any reason the liquid spray cannot be applied.

During the season just passed certain data on the effect of nicotine carrying substances upon apple leaf hopper and apple plant lice have been collected with a view to seeing whether dust applications could not be used for the control of these insects. The following table will serve to show the effect of a 90–10 sulfo-arsenical dust impregnated in one case with .5 of one per cent. nicotine, in another case with 1 per cent. nicotine and still another case with 3 per cent. nicotine as compared with a commercial lime sulfur (1 to 40) liquid spray, to which nicotine has been added at the rate of ¾ of a pint to 50 gallons.

Examination of the following table on leaf hopper results shows that the 90–10 dust impregnated with 1 per cent. nicotine is as effective as that charged with 3 per cent. and only a little more than one-half as effective as the liquid treatment.

| Date | Block | Row | No. cf Leaves | No. of Hoppers | Killing Agent |
|---|---|---|---|---|---|
| 6-8-'20 | 1 | 2 | 1,000 | 15 | Nicotine 5 percent. applied |
| " | 2 | 2 | 1,000 | 7 | " 1% " |
| " | 3 | 1 | 1,000 | 7 | " 3% " |
| " | 3 | 3 | 1,000 | 32 | " 3% possible floating |
| " | 4 | 2 | 1,000 | 76 | Owner's treatment |
| " | 5 | 2 | 1,000 | 4 | Nicotine ¾ pts. to 50 gallons |
| " | 4 | Checks | 1,000 | 108 | None |
| FROM DEMONSTRATION BLOCKS AT MAPLE SHADE | | | | | |
| 6-8-'20 | Original infestation estimated | | 3,000 | 9,000 | |
| " | Row 3 Extension Specialist ... | | 3,000 | 90 | Nicotine ¾ pts. to 50 gallons |
| " | Row 8 Experimentalist........ | | 3,000 | 25 | Nicotine ¾ pts. to 50 gallons |
| " | Row 13 Owner.............. | | 3,000 | 299 | Nicotine ¾ pts. to 50 gallons |

The following table will serve to show the comparative effects of a 90–10 sulfo-arsenical dust impregnated with .5 of one per cent. nicotine;

1 per cent. nicotine in another case and 3 per cent. nicotine in still another case in comparison with the effect of three-fourths of a pint of nicotine to 50 gallons of commercial liquid lime sulfur spray, both of the delayed dormant and summer dilutions.

| Date | Block | Rows | No. of Buds | No. of Lice | No. of Lice per Bud | Species of Lice | Killing Agent |
|---|---|---|---|---|---|---|---|
| | | | | | | | Nicotine |
| 4-24-'20 | 1 | 1-4 | 200 | 27 | .13 | Aphis avenae | Dust, 5% |
| " | 2 | 1-4 | 200 | 17 | .085 | " " | " 1% |
| " | 3 | | No counts | | | | " 3% |
| " | 4 | 1-4 | 200 | 76 | .38 | " " | L—S 1 to 40 |
| " | 5 | 1-4 | 200 | 10 | .05 | " " | L—S 1 to 40 Nicotine 40% ¾ pts. to 50 gals. |
| 4-29-'20 | 1 | 1-4 | 200 | 39 | .19 | " " | Dust, 5% |
| " | 2 | 1-4 | 200 | 10 | .05 | " " | " 1% |
| " | 3 | 1 & 2 | 200 | 1 | .005 | " " | " 3% |
| " | 4 | 3 & 4 | 200 | 9 | .045 | " " | L—S 1 to 40 Nicotine 40% ¾ pts. to 50 gallons |
| " | 5 | 1 & 3 | 400 | 0 | 0.0 | " " | L—S 1 to 40 |
| " | 5 | 2 & 4 | 400 | 0 | 0.0 | " " | L—S 1 to 40 Nicotine 40% ¾ pts. to 50 gallons |

The first section of the above table shows the comparative results of nicotine impregnated 90–10 dust and the delayed commercial lime-sulphur nicotine spray on the oat aphis but gives no data whatever of their relative effects upon the eggs because practically all specimens had hatched before the delayed dormant applications were made.

Both the first and second sections show, however, that while recently hatched aphids are more efficiently reduced by liquid treatments the 90–10 dust impregnated with one percent. or more of nicotine do very material execution indeed.

President W. A. Orton: The next paper is by Mr. A.L. Quaintance.

## DUSTING VERSUS SPRAYING OF APPLES

By A. L. Quaintance, *Entomologist in Charge Fruit Insect Investigations, Bureau of Entomology*

Different workers have recently rather fully summarized results of dusting apple orchards in comparison with spraying and reference to these experiments is here unnecessary, even were the time allotted me sufficient for this purpose. It is also quite unnecessary to dwell on the advantages, if effective, of dusting over spraying of orchards, since these advantages have been frequently pointed out and are furthermore perfectly obvious to any one experienced in orchard work.

It is the purpose of the present brief note to present in tabular form some results obtained by the Bureau of Entomology and Bureau of Plant

Industry during the last few years in dusting of apple orchards in comparison with spraying. The results in so far as relating to details lack much in definiteness and present frequent inconsistencies, but perhaps not more so than happens in experimental work of this character. The work was accomplished for the most part in a thorough-going and effective manner by men experienced in this kind of experimentation. In one or two instances the arrangement of plats in the experimental blocks was not entirely satisfactory, since it was not possible to obtain orchards of sufficient size. and of the right varieties to obviate some overflow of dust from one plat to another. No attempt will be made to draw detailed conclusions, as for instance, on the proper dosage of arsenate of lead, the matter of diluents, number of applications, etc. Certain general conclusions however appear to be warranted, which will be given below.

Table I gives results of dusting versus spraying apples at Benton Harbor, Mich., carried out under the direction of Mr. F. L. Simanton during the years 1915, 1916 and 1917, involving varieties of Rhode Island, Ben Davis and Baldwin. In some of this work Mr. Simanton was assisted by Mr. H. G. Ingerson and Mr. A. J. Ackerman, of this Bureau and Mr. Leslie Pierce, of the Bureau of Plant Industry.

In Tables II and III results are presented from Winchester, Va. of dusting versus spraying of apples during 1917 and 1918, carried out by Mr. B. R. Leach, of this Bureau. During 1917 scab results were not taken on the York Imperial, nor in 1918, since this variety is very little subject to this disease. Results on scab infection for 1918 however are shown in the case of Ben Davis variety.

Table IV presents results of dusting versus spraying of apples at Bentonville, Ark., during 1918, carried out by Mr. A. J. Ackerman, of this Bureau, and assisted by Mr. Leslie Pierce, of the Bureau of Plant Industry. In this work, in addition to results on codling moth and curculio, the effect of the treatments on apple scab and apple blotch was secured.

Table V presents work accomplished at Wallingford, Conn., during 1918, carried out by Mr. E. H. Siegler and Mr. B. A. Porter on McIntosh and Baldwin varieties. Scab results were taken on the McIntosh variety, but as will be noted from the figures, there was practically no scab present.

Table VI presents results of dusting versus spraying of apples at Grand Junction, Colo., on the Ben Davis variety during 1917. This work was carried out by Mr. L. C. Antles and H. K. Plank of this Bureau. Results on the codling moth only are presented, since in this arid region fungous diseases of the fruit are of no importance.

TABLE I—DUSTING VS. SPRAYING APPLES—BENTON HARBOR, MICH.

*1915—Rhode Island Greening*

| Plat No. | Materials[1] | Percent. fruit free from | | |
|---|---|---|---|---|
| | | Codling moth | Curculio | Scab |
| I—Liquid | A. L. 1-50; L. S. 1-½-50 | 96 | 94 | 95 |
| II—Dust | A. L. 10%; S. 40%; L. 50% | 95 | 87 | 73 |
| III " | A. L. 15%; S. 40%; T. A. 45% | 96 | 94 | 71 |
| IV " | A. L. 25%; S. 75% | 97 | 89 | 75 |
| V—Check | No treatments | 75 | 82 | 39 |

Above treaments given for calyx and subsequent applications—For "pink spray" the following were used: Plat I—L. S. 1-½-50; II and III, S. 50%; L. 50%; IV, S. 75%; L. 25%.

*1915—Ben Davis*

| | | | | |
|---|---|---|---|---|
| I—Liquid | A. L. 1-50; L. S. 1-½-50 | 97 | 94 | 98 |
| II " | " " | 97 | 91 | 98 |
| III—Dust | A. L. 10%; S. 40%; L. 50% | 98 | 92 | 49 |
| IV " | A. L. 15%; S. 40%; T. A. 45% | 97 | 93 | 53 |
| V " | A. L. 25%; S. 75% | 97 | 90 | 70 |
| VI Check | No treatments | 91 | 87 | 16 |

Above treatments given for calyx and subsequent treatments. For "pink spray" following were used: Plats I and II, L. S. 1-½-50; III and IV, S. 50%; L. 50%; V, S. 100%.

[1] A. L.—Arsenate of lead L. S.—Lime sulphur. S.—Sulphur. L.—Lime. T. A.—Terra Alba.

*1916—Ben Davis*

| Plat No. | Materials | Percent. fruit free from | | |
|---|---|---|---|---|
| | | Codling moth | Curculio | Scab |
| I—Liquid | A. L. 1-50; L. S. 1-½-50 ......... | 97 | 85 | 83 |
| II—Dust | A. L. 5%; S. 50%; L. 45% ....... | 90 | 50 | 15 |
| III " | A. L. 10%; S. 65%; L. 25% ...... | 97 | 86 | 17 |
| IV " | A. L. 15%; S. 75%; L. 10% ..... | 99 | 92 | 29 |
| V " | A. L. 20%; S. 80% ............... | 98 | 89 | 21 |
| VI—Check | No treatments .................. | 65 | 47 | 10 |

Above treatments given for calyx and subsequent applications For "pink spray" following were given: Plat I, L. S. 1-½-50; II, S. 50%, L. 50%; III, S. 65% L. 35%; IV, S. 75%; L. 25%; V S. 80%; A. L. 20%.

*1916—Baldwin*

| | | | | |
|---|---|---|---|---|
| I—Liquid | A. L. 1-50; L. S. 1-1½-50 ........ | 91 | 85 | 84 |
| II—Dust. | A. Lime 7.5%; S. 60%; L. 32.5% | 85 | 84 | 34 |
| III " | A. L. 10%; S. 65%; L. 25% ...... | 91 | 87 | 37 |
| IV " | A. L. 15%; S. 75%; L. 10% ...... | 94 | 89 | 39 |
| V " | A. L. 25%; S. 75% ............... | 94 | 87 | 55 |
| VI—Check | No treatments .................. | 51 | 76 | 22 |

The above treatments given for calyx and subsequent applications. For "pink spray" the following were used: Plat I, L. S. 1-½-50; II and III, S. 65%, L. 35%; IV, S. 75%, L. 25%; V, S. 80%; A. L. 20%.

*1917—Baldwin*

| Plat No. | Materials | Percent. fruit free from | | |
|---|---|---|---|---|
| | | Codling moth | Curculio | Scab |
| I—Liquid | A. L. 1-50; L. S. 1-½-50 ......... | 87 | 83 | 95 |
| II—Dust | A. L. 10%; S. 65%; L. 25% ...... | 84 | 88 | 61 |
| III " | A. L. 15%; S. 85% .............. | 80 | 84 | 62 |
| IV " | A. L. 15%; S. 75%; L. 10% ...... | 94 | 89 | 80 |
| V " | A. L. 33%; S. 67% ............... | 92 | 90 | 87 |
| VI—Check | No treatments .................. | 50 | 89 | 32 |

Above treatments given for calyx and subsequent applications. For "pink spray" following were used: Plat I, L. S. 1-½-50; II, S. 65%, L. 35%; III, S. 100%; IV, S. 85%, L. 15%; V, S, 67%; A. L. 33%.

TABLE II—DUSTING *vs.* SPRAYING APPLES, WINCHESTER, VA. 1917

| Plat No. | Treatment Calyx; 3–4 weeks later; 8–9 weeks after calyx | Ben Davis | York Imperial | York Imperial |
|---|---|---|---|---|
| | | Percent. free from | | |
| | | Codling moth | Codling moth | Codling moth |
| I—Liquid | A. L. 1-50; L. S. 1-½-50 | 99 | 97 | 98 |
| II—Dust | A. L. 15%; S. 50%; L. 35% | 99 | 97 | 99 |
| III " | A. L. 15%; L. 85% | | 96 | 99 |
| IV—Check | No treatments | 69 | 46 | 67 |

TABLE III—DUSTING *vs.* SPRAYING APPLES, WINCHESTER, VA., 1918

| Plat No. | Treatment Calyx; 3–4 weeks later 8–9 weeks after calyx | Ben Davis | | York Imperial |
|---|---|---|---|---|
| | | Per cent free from | | |
| | | Codling moth | Scab | Codling moth |
| I—Liquid | A. L. 1-50; L. S. 1-½-50 | 96 | 92 | 98 |
| II—Dust | A. L. 10%; S. 50%; L. 40% | 95 | 54 | 98 |
| III " | A. L. 15%; S. 50%; L. 35% | 98 | — | 97 |
| IV " | A. L. 15%; L. 85% | — | — | 91 |
| V Check | No treatments | 54 | 34 | 81 |

TABLE IV—DUSTING *vs.* SPRAYING APPLES, BENTONVILLE, ARK., 1918

*Ben Davis*

| Plat No. | Pink Spray | Calyx and later treatments, 5 in all | Per cent, free from | | | |
|---|---|---|---|---|---|---|
| | | | Codling moth | Curculio | Scab | Blotch |
| I—Liquid | L. S. 1-½-50 | A. L. 1-50; L. S. 1-½-50 | 69 | 87 | 89 | 91 |
| II—Dust | S. 85%; L. 15% | A. L. 15%; S. 85% | 30 | 87 | 64 | 79 |
| III—Check | No treatments | | 27 | 60 | 10 | 84 |

TABLE V—DUSTING *vs.* SPRAYING APPLES, WALLINGFORD, CONN. 1918

*McIntosh*

| Plat No. | Pink Spray | Calyx treatment (only two applications made) | Percent. free from | | |
|---|---|---|---|---|---|
| | | | Codling moth | Curculio | Scab |
| I—Liquid | L. S. 1-½-50 | A. L. 1-50; L. S. 1-½-50 | 97 | 84 | 99 |
| II—Dust | S. 50%; L. 50% | A.L. 10%; S. 50%; L.40 % | 98 | 84 | 99 |
| III " | S 75%; L. 25% | A. L. 10%, S. 75%; L. 15% | 98 | 85 | 99 |
| IV—Check | No treatments | | 94 | 62 | 99 |

*Baldwin*

| | | | | |
|---|---|---|---|---|
| I—Liquid | L. S. 1-½-50 | A. L. 1-50; L.S. 1-½-50 | 99 | 72 |
| II " | | A. L. 1-50; L. S. 1-½-50 | 99 | 74 |
| III—Dust | | A. L. 5%-S. 50%; L. 45% | 99 | 65 |
| IV " | S. 75%; L. 25% | A. L. 10%; S. 75%; L.15% | 99 | 71 |
| V " | | A.L. 10%; S. 50% L.40% | 99 | 61 |
| VI " | | A.L. 15%; S. 25%; L. 60% | 99 | 63 |
| VII—Check | No treatments | | 92 | 27 |

TABLE VI—DUSTING *vs.* SPRAYING APPLES, GRAND JUNCTION, COLO. 1917

*Ben Davis*

| Plat No. | Treatment calyx, and subsequent applications. Six in all | Per cent. fruit free from codling moth |
|---|---|---|
| I—Liquid | A. L. 1-50 | 62 |
| II—Dust | A. L. 20%; L. 80% | 40 |
| III " | A. L. 15%; L. 85% | 34 |
| IV " | A. L. 10%; L. 90% | 14 |
| V—Check | No treatments | 8 |

From the Bureau's experiments in dusting versus spraying of apples, as indicated above, and from considerable observation on this work it is

felt that the following general conclusions in regard to the codling moth and plum curculio are warranted.

In regions where the codling moth is not especially severe, as in the New England States and other more northern States, dusting controls this insect practically as well or as well as spraying. In regions where the codling moth is more abundant, due to a larger second brood or to subsequent broods of larvae, as in Maryland, Virginia, Illinois, the Ozarks, etc., dusting is not a satisfactory control. In such arid regions as the Grand Valley, Colo., where the codling moth is very prolific and injurious dusting is notably less effective than spraying.

In the case of the plum curculio on apples, dusting compares favorably with spraying where the insect is not especially abundant. Under conditions of curculio abundance, as is often the case in orchards in sod, dusting is not an effective control for this insect and spraying under these conditions may not furnish the protection desired.

The results given in the tables on the control of scab, brown-rot, and apple blotch are presented for the consideration of Pathologists interested in the subject. In reference to comparative merits of dusting and spraying in apple disease control, Prof. Waite has recently expressed himself as follows (Annual Report, Bureau of Plant Industry, for the fiscal year ending June 30, 1920, page 61):

Comparative tests of dusting and spraying methods were continued in both peach and apple orchards. In the case of the peach the tests were particularly severe, and neither spray nor dust gave as good control of brown-rot as was expected. The dust was about as efficient as the spray. In the case of the apple, as in previous years scab black-rot, leaf-spot blotch, sooty blotch and bitter rot were not controlled by dusting. To the list of diseases almost entirely prevented by spraying but not controlled by dusting was added the New Hampshire fruit-spot, which was especially destructive in the Ozarks, where our experiments were carried on.

## Dusting Versus Spraying of Peaches

Considerable work has been done in dusting peaches in comparison with spraying for the control of the plum curculio, scab and brown-rot in different parts of the country, but little of this work has been entirely satisfactory from the experimental standpoint owing to the scarcity in the same orchard of one or more of these troubles. The most conclusive results obtained come from Mississippi and Georgia and indicate that during periods of average abundance and under average weather conditions dusting is about as effective as spraying for these three peach troubles. It should be pointed out however that during the last two seasons in Georgia, where the weather has been unusually hot and rainy,

neither dusting nor spraying gave much benefit and there was a heavy loss of fruit in some parts in spite of very thorough dusting and spraying by the growers.

President W. A. Orton: Problems of plant pathology beginning with truck crop diseases will be discussed by Mr. H. A. Edson of the Bureau of Plant Industry.

The discussion was informal and no paper was submitted.

President W. A. Orton: The last paper is entitled "Problems Associated with the Control of Plant Diseases in Orchards," and will be presented by Mr. N. J. Giddings, Morgantown, W. Va.

## ORCHARD DUSTING VERSUS SPRAYING

By N. J. Giddings, *Morgantown, W. Va.*

In the few moments available I wish to present first a note regarding the use of dust on peaches; second a brief review of our own experiments with dust for control of apple diseases in West Virginia; third to give a more general survey of the work along that line; and fourth to submit a few home-brewed, and re-distilled statements for your kind consideration.

There seems to be no question as to the effectiveness of sulphur dust for the control of peach scab. In our experimental work the control with dust averaged a little better than with spray. Our data on brown rot control are rather inadequate because the amount of infection was light, but the results indicated that the dust was just about as effective as spray. The details of our work on peaches are given in West Virginia Experiment Station Bulletin No. 167. Some investigators have reported fruit and foliage injury from the use of sulphur dust on peaches, but we feel that this injury can be reduced to a negligible minimum in actual orchard practice in West Virginia. We found such injury only when excessive amounts of material were used.

The attractive features of dust applications were first brought to my attention in 1912–13. Professor Peairs, our entomologist having had experience with dusting, was favorably impressed with the method, and anxious to give it a further trial. I was at least reasonably optimistic, so our experimental work was undertaken with the most sincere hope of success, supplemented by the determination that the work should be thoroughly and carefully carried out.

Our first work was conducted in orchards where scab failed to develop sufficiently to warrant drawing any conclusions. For our later work we were very careful to select orchards in which this disease was prevalent.

In all of this work we have used the sulphur-arsenate dust, and during the past two seasons a number of special dusts have been tested. Among these were copper-lime dust, containing 20 percent. dehydrated copper sulphate and two percent. copper carbonate; copper-lime dust, containing 10 percent. dehydrated copper sulphate; copper-lime dust, containing 15 per cent. dehydrated copper sulphate and 15 percent. Venetian red; commercial Bordeaux dust (11 percent. copper) with an equal amount of hydrated lime; the preceding mixture with the addition of 2½ per cent. acacia; dry lime sulphur diluted with an equal amount of rye flour; and sulphur dust containing 14 percent. dry lime sulphur. Approximately 10 per cent. of lead arsenate was included in each of the foregoing mixtures. The Bordeaux dusts were used three seasons and the copper-lime dusts have been tried during the past two seasons.

Without definitely condemning any of the preceding mixtures it may be noted that the materials which gave best results were the copper-lime-Venetian red, and the sulphur-lime sulphur, with many points in favor of the latter. We plan to test this mixture (sulphur 75, lime sulphur 15, lead arsenate 10) again during the coming season and hope to try others of a somewhat similar character. We feel that the standard sulphur-arsenate mixture is a good base because of its physical properties and fungicidal action, but that some more active agent such as copper or the dry lime sulphur may prove to be a desirable constituent.

In all of our experimental work the 3–5–50 Bordeaux spray has been the most effective fungicide and the lime sulphur spray next in value. We believe that our data for the past two seasons were secured under conditions which warrant close comparisons, and that the results are reasonably reliable for the materials used. The equipment available and the climatic relationships of the particular regions in question must also be considered in connection with any data of this kind.

Experiments in 1919

| | Check | Bordeaux spray | Copper-lime dust | Sulphur dust | Lime sulphur spray |
|---|---|---|---|---|---|
| *Foliage data:* | | | | | |
| Leaf spot (Percent. of leaves diseased) .. | 78.1 | 52.9 | 61.5 | 60.8 | 35.0 |
| Leaf spot (*spots* per infected leaf)....... | 6.0 | 2.3 | 2.8 | 2.8 | 2.0 |
| Percent of scabby leaves.......... | 75.4 | 61.3 | 68.8 | 69.8 | 61.5 |
| *Fruit Data:* | | | | | |
| Percent. scabby fruit (total)..... | 98.4 | 34.5 | 92.8 | 83.0 | 52.8 |
| Percent. light scab.............. | 9.1 | 17.9 | 29.0 | 37.6 | 23.6 |

Experiments in 1920

(*Orchard No. 1*)

| | Check | Bordeaux spray | Copper-lime dust | Sulphur dust | Lime sulphur spray |
|---|---|---|---|---|---|
| *Foliage data:* | | | | | |
| Percent. scabby leaves.......... | 80.4 | 1.8 | 60.1 | 23.2 | 23.3 |
| *Fruit data:* | | | | | |
| Percent. scabby fruit (total)..... | 91.1 | 31.3 | 80.5 | 77.9 | 46.0 |
| Percent. light scab.............. | 20.0 | 17.8 | 35.3 | 34.3 | 28.3 |

(*Orchard No. 2*)

| | | | | | Sulphur-lime sulphur dust |
|---|---|---|---|---|---|
| *Foliage data:* | | | | | |
| Leaf spot (Percent. leaves diseased) | 80.0 | 32.9 | 60.4 | 46.4 | 26.4 |
| Leaf spot (*Spots* per infected leaf) | 20.8 | 2.8 | 5.0 | 3.5 | 1.7 |
| Percent. scabby leaves | 53.6 | 7.7 | 14.9 | 10.1 | 3.9 |
| *Fruit data:* | | | | | |
| Percent. scabby fruit (total) | 95.2 | 21.5 | 90.5 | 71.2 | 51.8 |
| Percent. light scab | 18.3 | 8.1 | 39.6 | 23.6 | 19.7 |
| Percent. sooty blotch | 99.5 | 5.0 | 89.9 | 79.8 | 54.2 |

Please note that the results from use of sulphur-lime sulphur dust are included merely because they indicate a hopeful line for further experimental work. The combination of natural conditions which helped to bring about these results may have been far from normal, but we are inclined to believe that such was not the case.

Our results have indicated that sulphur dust is not so effective as either the lime sulphur spray or the Bordeaux spray for control of apple scab in West Virginia orchards where the disease is severe.

We have found that it is absolutely essential to apply the dust in the early morning, and undoubtedly it would be preferable to apply it soon after midnight as some are already doing. We have found that the dust machines available do not have sufficient power and do not expel the dust with sufficient force. We believe that the discharge tube could well be arranged so as to give better distribution of the dust as it leaves the machine.

We have also found that applications of different materials must all be made on the same day if any comparisons are to be considered. We have a large amount of data, including special experiments, which shows that a difference of one to three days between the dates of application of various materials or between applications of the same material will often decrease or increase the relative effectiveness to such an extent as to indicate clear-cut success on the one hand and extreme failure on the other.

Turning now to a general survey of the work, I will endeavor to interpret it from my point of view. I hope to keep within reasonable bounds, for this idea of interpreting the other fellow's data is a very dangerous pastime. Considering, first, the 1920 season, Michigan and Virginia present strong evidence as to the value of sulphur dust against apple scab. In Virginia seven applications of material were given. It seems to me that we should reduce this number of treatments. Pennsylvania reports good results from dust in two orchards and just fair comparative control in a third. Five applications were given in each of these orchards.

The data secured in Connecticut are of particular interest, and the following figures are presented with due acknowledgments to Dr. G. P. Clinton and Mr. E. M. Stoddard.

PERCENTAGE OF SCAB IN PLOTS

| *Variety* | *Check* | *Dust*[1] | *Spray* |
|---|---|---|---|
| Fall Pippin | 56.3 | 48.9 | 7.75 |
| McIntosh | 37.25 | 13.79 | 1.08 |
| Greening | 10.85 | 1.17 | 0.48 |

These figures indicate that the dust was of far greater relative effectiveness where the amount of scab was slight than where the infection was reasonably severe. On the other hand we must keep in mind the fact that this experiment deals with different varieties, and there may be other factors which should be considered. In Pennsylvania Mr. R. C. Walton called attention to the fact that their results with dust in 1919 were strongly negative and that the amount of infection was high, while they secured far more favorable results in 1920 when the general scab infection was much less severe.

Nova Scotia, using four applications, and West Virginia, using three applications in one orchard and four in another, also give evidence which is distinctly unfavorable to sulphur dust.

It might be mentioned at this time that in comparing these data I have assumed that, if the sprayed plot gave over ten percent. more sound fruit than the dusted plot under similar conditions, the dust was comparatively inefficient.

The results reviewed for the season of 1920 are reasonably similar to those for previous seasons but the time will not permit further discussion.

Now I wish to present certain conclusions and suggestions based upon our experiences in connection with this work in West Virginia, and the available data from other sources. The problem itself should receive attention from three distinct angles (equipment, materials, and methods). I have already stated what we believe to be some of the more important improvements needed in the equipment for applying dust, and will not stop to discuss further details here. When it comes to the question of materials, I believe that we are grossly ignorant. Take for example the one material, *sulphur dust, when in contact with living plant tissue*, and consider the factors mentioned in the following questions, as to their influence on the fungicidal action, or the injuriously toxic properties of this dust.

[1]This was the so-called "3 in 1" dust, containing three percent. of nicotine. The treated plots each received four applications

What is the effect of sunlight?
What is the effect of heat?
What is the effect of diurnal temperature variation?
What is the effect of moisture?
What is the combined effect of moisture and temperature variations?

Is there any consistent and pronounced difference in the action of this material upon different varieties or species of plant, and if so why?

Perhaps some of you are now convinced that the dusting problem has been too great a strain upon me, but let me assure you in all seriousness that our progress in phytopathology will eventually be based upon the correct answers to such fundamental questions. A reasonable knowledge regarding these factors will save many disputes and misunderstandings, and will explain many of those things which we, "are sure cannot be so," but which *are so*.

The above-mentioned questions must also be applied to dust combinations such as the sulphur-arsenate, copper-lime-arsenate, sulphur-lime sulphur-arsenate, and others. As already indicated, there are numerous other materials or combinations of materials which are worthy of consideration, and possibly of trial.

Methods of treatment and methods of handling results are also worthy of study. This is a field in which we should be able to agree to a reasonable extent. There has undoubtedly been a considerable and steady improvement in methods, but it must continue. New developments in equipment and materials will also have their effect upon methods of treatment.

There is a vast amount of work to be done. The field is large and no one institution will be likely to solve many of the problems involved. By reasonable co-operation the progress will be more rapid, but we will need abundant help from chemistry and physiology. In this case our problem is also the problem of entomology and horticulture and we know that their co-operation is assured.

There is a strong natural tendency to publish positive results and to avoid the publication of negative results. This is an unfortunate trait, for the negative data from a good investigation, well conducted, are of greater actual value than positive data from a similar investigation poorly conducted.

I believe that all of us should submit the results of our investigations to disinterested, but capable, parties who will give them their frank and careful criticism before we turn them over to the printer. I am certain that such action would prevent many unintentionally misleading statements which find their way into print.

Premature publication is common, while over-delayed publication is rare. The mere fact that sulphur-lime sulphur-arsenate dust gave us good results in 1920 is no warrant for me to recommend it as a practical treatment, and assume that it will prove effective in 1921 and 1922. Permit a digression here to state that one certainly recommends a material or a practice if he submits a favorable report with favorable conclusions to the general public who are likely to be influenced by it in their commercial operations. If we do not secure consistently favorable results during at least three successive seasons, I do not believe that we have any right to place suggestively favorable evidence before the consuming public. By disregard of any such rule one not only does an injustice to the horticulturist and the orchardist, but he actually injures the status of plant pathology to a very serious extent.

Let me quote from a couple of letters which happen to be from outside West Virginia but which describe the conditions in this state very accurately.

"We have a great many dust machines around among the growers but these machines are lying idle this year."

"For your information, I wish to state that the writer has personally used the dusting method in his own orchard during the years 1917 and 1918 upon apples at Springdale, Washington County, Arkansas, and the results that we got at that time were very disastrous, as were results of growers at Rogers and Bentonville of Benton County, Arkansas, during those two years."

I have recently talked with two of our largest and most progressive commercial apple growers and these men have suffered extreme losses as a result of their endeavors to control apple diseases (specifically scab) by the use of sulphur dust. They made numerous applications. They bent every effort toward accomplishing the desired end. They failed disastrously. Both have definitely abandoned any further attempts to use dust, and it will require extremely convincing evidence before we can ever induce them to take up dusting again, even in case improved machinery and new dust mixtures should be found effective. The seriousness of such a situation need hardly be pointed out, and we should spare no efforts to avoid things of this kind.

Personally, I am hopeful for the future of dust applications for the control of many orchard diseases. I do not believe that dust will entirely take the place of spray, but I do believe that it will eventually fall into line and will be accepted as the best method for control of certain diseases under certain general conditions. At the same time I am quite positive that there must be improvements made in the machinery and in the nature of the dust applied before it can come into successful general use among apple growers.

President Newell assumes the chair.

PRESIDENT W. A. ORTON: Three points in particular I want to mention with respect to dusting for the control of both insects and plant diseases: First, that our outlook be from this time forward, and not backward,—toward the possibility of success in the future regardless of failures in the past; second, let us organize our work to bring to bear upon these problems the best help of all kinds of specialists concerned—entomologists, pathologists, chemists, engineers, and farmers; third, that our experimental methods should be adapted to the complexity of the problem.

With respect to this morning's discussion, it seems to me that it is not worth while for any of us to speak in the discussion upon our past failures unless we know the reason why. We have had lots of them. In the field of truck crop diseases the failures far outnumber the successes, but we do feel that the whole question of dusting ought to be reopened, because the fruit and truck growing industries demand that simpler and easier methods of disease control should be introduced.

I feel personally, particularly in our own field, the very great importance of concentrating the services of specialists in many different lines. We cannot as pathologists feel that we are planning our work properly unless we are advised as to the life history of the insects which have to be dealt with. We need the help of the chemist to determine the composition of our mixtures; we need the help of the plant physiologist to determine the reaction of the chemicals upon the plants; we need the help of the chemist to determine by actual analysis what amount of fungicides may be present upon the leaves, what amount is washed off by the rains, the relative adhesiveness of the compounds. We need the help of the engineer to plan better machinery for applying our fungicides and insecticides.

Our experimental methods, I feel, have not been planned correctly. One speaker has mentioned that results differ greatly if a short time intervenes between the applications that are being compared. One spray on one day and another three days later give different results. That is true, but are we not making a mistake in planning our experiments in the office in the beginning of the season and carrying them through on a fixed schedule regardless of developments during the season. When we plan to spray every two weeks, such and such a mixture, such and such quantities, are we not like the general in the war who says "I will fire my guns in the general direction of the enemy at ten o'clock on Mondays, Wednesdays and Fridays?" The chances are if he does so the enemy is still snugly protected in bomb-proof dug-outs, or has not yet come out in the field, or is forward in the skirmish line. Now we

are in a battle and our enemies, these diseases and insects, are not following any fixed dates. The insects emerge and lay their eggs and pass from one stage to another depending upon temperature and other conditions. Our fungi germinate their spores with reference to moisture and temperature. We, as experimenters, have got to know just when the critical stage is when we can deliver our broadsides most effectively. What we want to do is to put ourselves in the grower's place to work out a method of disease control and insect control that will be effective and cheaper than the present method. If that calls for six applications of dust or eight applications of dust when the standard number of sprays is three or four, let's do it that way. The real test of the relative merit of the two methods comes from the economic standpoint. Can we control insects and diseases more effectively and more cheaply by a method of dusting than by a method of spraying?

President Wilmon Newell: The entire subject is now open for general discussion.

A Member: I should like to ask Mr. Giddings with reference to the various dusts applied, whether the materials that were used to secure adhesiveness were successful. If so, which was the best?

Mr. N. J. Giddings: They were not particularly successful. The Venetian Red was used not particularly to secure adhesiveness but to help in carrying the material through. It gave evidence of other trouble in the machine which I do not think would warrant its use. The others we did not think were worth while.

Mr. William Moore: I presume that in the experiments with nicotine dusts the half percent. of nicotine given is the total nicotine found in the dust. We all know the principle of the gas mask—a finely divided solid through which the air was drawn to the soldier; the poison gas never reached him, as it was adsorbed by the solid. Any solid which is finely divided and presents a large surface may adsorb certain liquids, gases or even other solids. In this particular case there is a possibility of the adsorption of nicotine, thus locking it up and making it unavailable. Another question is that nicotine sulphate itself is non-volatile. How was this loosened up? I don't suppose that the nicotine would become effective against the insect until at such time as it became volatile. You thus have two possibilities of reducing the amount of nicotine that was actually effective against the insect. When we consider the cost of nicotine it is not advisable to lock up any in such a way.

I wish to point out that different materials will give you different results. I know nothing about it, but would assume from the nature of the materials that a sulphur with nicotine added would have more

available nicotine than a clay with nicotine added, although you add the same amount of nicotine in each case.

I would like to know whether any experiments have been conducted with clays and nicotine as well as sulphur and nicotine.

MR. RUTH: Sulphur will volatilize by hydrolysis of water.

MR. ALVAH PETERSON: I have some points along this line that may be of interest. During the past season we conducted experiments on various plant lice with nicotine impregnation in the various substances. For the most part we used different kinds of clay and impregnated these with varying amounts of nicotine sulphate. We found as Dr. Moore has suggested that when we made a two percent. mixture of nicotine sulphate in clay, we obtained, as I recall now, about the same killing effect as when we used a half per cent. of nicotine in clay with addition of ground stone lime. Hydrated lime did not give as good results as stone lime finely ground. We know that when lime is added to a nicotine compound such as nicotine sulphate, it liberates nicotine. This combination gave us a very effective dust for the potato aphis.

MR. WILLIAM MOORE: When you add lime to clay (clay is colloidal or almost collodial) it precipitates the clay, flocculates it, I believe they call it in soil chemistry. Precipitation reduces the surface and also the amount of the nicotine that can be adsorbed so you also have a freeing of nicotine from that source as well.

PRESIDENT W. A. ORTON: You know that we have been doing a whole lot of work lately on the mosaics, one of the most important groups of plant diseases, which are carried from field to field and plant to plant by aphids. It is manifestly evident that control of mosaic diseases is very largely dependent upon aphid control. We have been greatly interested to hear that dust combinations of nicotine with, I think, kaolin or lime are being introduced by the entomologists. I wish we might hear something about that from someone who has had experience.

MR. P. J PARROTT: I would say, Mr. Chairman, that the control of the potato aphis and the potato leaf-hopper by dusting is largely in the experimental stage, and the situation with regard to these species is not very different from that of the apple aphids, redbugs and other insects which I considered in my paper. The potato aphis and leafhopper nymphs are susceptible to dusting preparations containing nicotine. But the selection of insecticides is only one factor of the problem, and as far as these insects are concerned there is a serious need of machinery capable of dusting the undersurfaces of potato foliage, as well as data on the effectiveness of this system of treatment in controlling the common potato diseases. Thorough applications of dust kill a large percent-

age of the aphids, but it is interesting to note that the potato aphis proved, in our experiments, to be more resistant to dust mixtures with nicotine than the apple species. Preparations with two percent. nicotine are expensive, and the cost makes the treatment impractical except for experimental operations. In addition to encouraging improvements in machinery, experimental workers should lend their efforts to the production of cheaper insecticides and fungicides in dust form. The future progress of dusting truck crops depends to a large extent on the solution of these problems.

President W. A. Orton: We have to deal not only with the potato, but other crops. Spinach blight, so-called, is a mosaic disease very prevalent in Virginia, Ohio, and other states. The aphis spreads the spinach mosaic and ought to be controlled. Cucumber mosaic, the principal limiting factor in the pickle industry of the Great Lakes States, is spread mainly by aphids. If we can have effective methods of aphis control of cucumbers, we can pretty nearly revolutionize the cultivation of cucumbers for pickles. Potato mosaic is getting more abundant every year and new hosts of mosaics are constantly brought to our attention. It is likely that there is insect transmission in all cases, consequently the men who are experimenting with means for destroying aphids have a big work cut out for them, and an opportunity to do a very large service in the control of plant diseases.

Mr. McClintock: I would like to ask the entomologists a question. Certain agents, who are selling dusts at the present time for the control of insects in peaches, state that the sulphur in the dust has some repellent action as far as curculio are concerned. I would like to have that question answered, and further if there would be any advantage in a dust, in having the nicotine, as a repellent to the curculio.

Mr. A. L. Quaintance: I think that dust on the peach tree might have some repellent action. I don't think it would be sufficiently repellent to afford protection from the curculio. I doubt if the nicotine would be of very much value, not enough to warrant its cost. The treatment for curculio is arsenate of lead.

Mr. L. R. Taft: We were very properly warned by the Chairman against stating premature conclusions. I wish to state my conclusions after thirty years' experience with dusting and spraying carrying them on in an experimental way, and also watching the results obtained by practical fruit growers.

I am convinced that in Michigan, at least, we can get practically as good results against curculio and the codling moth with the arsenical dusts as with the ordinary sprays, but we fail when using dust against

the different aphids, red bugs and similar insects. When used against fungous diseases the results have been less satisfactory, and regarding the use of dust for apple scab and similar fungi, I agree perfectly with Dr. Headlee in his conclusions, and have advised Michigan fruit growers to "spray when you can for the apple scab, and when you cannot spray, dust."

In Michigan, many of our best fruit growers are becoming very enthusiastic over dusting for apple scab. They had sprayed for years with Bordeaux or lime-sulphur solution but in some seasons had russeted the fruit badly with Bordeaux mixture, and had burned the leaves, especially in hot weather, when they had used lime-sulphur sprays. For the last four years, the weather in the southern part of the State has been comparatively dry during the spring and early summer and they have been able to control apple scab practically as well with the ordinary sulphur dust as with lime-sulphur sprays. In the northern part of the State, where the weather has not been as warm, and where rains have been more frequent, the results have been less satisfactory. We visited one forty acre orchard containing mostly Baldwin and Northern Spy trees in July and again in August, 1920, which had received three applications of dust. One was given when the trees were in the pink; the second immediately after the fruit had set; and a third two weeks later. The fruit was so badly infested with apple-scab that the owner considered the crop worthless for packing and sold the entire 20,000 bushels for cider. The results were not unlike those secured in Michigan by Dr. Quaintance in 1916 in an experiment carried on at Benton Harbor under the direction of Professor Simanton. The Ben Davis and Northern Spy apples upon which dusts were used were quite badly infected with scab, while the sprayed trees were practically free from that disease. They also agreed with those secured by Mr. Dutton of the Michigan Experiment Station in 1915. Although the trees were very carefully dusted, when the crop was harvested, it was difficult to note any difference between the dusted and the check trees. In 1915, the season in Michigan was very wet, there being some twenty-six rainy days during the month of July. Frequent rains in 1916 also had much to do with the development of apple scab upon the Benton Harbor orchard reported by Dr. Quaintance.

From the fact that dusting is a rapid method of treating the trees, a large number of Michigan fruit growers with orchards of from 20 to 100 acres are now relying almost entirely upon their dusting machines except for their dormant sprays. They have been well satisfied with the results secured in dry seasons but we fear that they will not be so successful in controlling the apple scab and other fungous diseases in wet seasons

which they are likely to have at any time. For this reason, while we advise all fruit growers having extensive orchards to procure a dusting machine, we believe that it should be used to supplement the spray rig and to aid in supplying a fungicide to the trees when weather or other conditions make it impossible to provide fungicides for their protection in a liquid form. Our experience leads us to believe that whether or not success against fungi can be secured with dusting will be determined by the character of the weather.

Mr. William Moore: Some one has said that nicotine sulphate is not volatile, pointing out that it hydrolyzes and was then volatile. When it hydrolyzes it is no longer nicotine sulphate. Nicotine sulphate is not volatile.

Mr. Ruth: I made that statement. It does hydrolyze and the nicotine becomes volatile as nicotine. Therefore you can obtain the result with nicotine sulphate by its hydrolysis, which I believe is essentially a correct statement.

Mr. William Moore: In dusts you will not have a high degree of hydrolysis since the amount of water present is very small.

Mr. Ruth: The amount of water is adsorbed just as the nicotine is adsorbed.

Mr. McClintock: I would like to ask Mr. Quaintance a question. He knows the severe curculio situation in Georgia. Under those conditions, would there be any advantage in applying a spray or dust earlier than the ones usually put on; then again, another one later, very close to the time of harvest.

Mr. A. L. Quaintance: The peach spraying schedule provides for two arsenate of lead applications. On the average, that is about all that it is safe to apply. A plan to put on additional treatments has been followed by several orchardists. In some seasons the injury has not been great; in other seasons the injury has been worse than the curculio or brown rot. I think some of the growers in the Ft. Valley section will this year apply three or perhaps four applications of arsenate of lead. The first application will be made as soon as the blossoms fall. The use of arsenate on the fruit shortly before harvest is to be discouraged. Probably, however, a good many growers will make a fourth application of arsenate at about that time.

The present situation as to the curculio in Georgia is due apparently to weather conditions. For the past two seasons they have had excessive rains and hot weather. The curculio in the course of its life cycle goes into the ground. It is well known to those who have studied this insect that showers, softening the earth, are very favorable to the

emergence of the beetles, whereas dry weather effects the destruction of a great many of them in the soil. Rainy weather furthermore keeps down a number of important parasites.

Under the hot humid conditions in Georgia, the plum curculio has developed apparently a partial second generation, and it is this supposed second generation that is responsible for the large amount of ripe, wormy peaches.

The campaign against the curculio in that section should be to destroy beetles of the first generation by all means possible. Growers will doubtless burn the areas around the orchards, destroy plum thickets, and thus kill the insect in hibernation. They will spray three or four times, collect fallen fruit under the trees that contain the grubs, and perhaps some of them will resort to the old "jarring" method which was discarded with the advent of sprays.

Mr. McClintock: Do you think that is practical for the Georgia orchards where they have thirty or forty thousand trees?

Mr. A. L. Quaintance: It is a question of man power. They have been doing operations on a large scale. The negro help is becoming abundant. They will do the best they can.

That is the reason that dusting has had so much favor and has been so much in vogue in that region. That is one reason why it is fortunate that dusting has a place in peach growing. Conditions are much improved and many of the orchardists are in condition and prepared to carry out extensive programs of curculio repression.

Mr. V. I. Safro: Just to try to settle some misunderstanding that may yet remain as regards this nicotine discussion, I want to say that both Professor Moore and Professor Ruth are correct. Nicotine sulphate is not volatile, but it doesn't remain nicotine sulphate long under ordinary conditions. The ordinary water, as it is used throughout the United States, has enough elements in it to break down nicotine sulphate, and what you get when it finally reaches the tree is free nicotine which is volatile, so both of these gentlemen are correct. Dr. Moore has an uncanny habit of explaining things that have puzzled us for a long time and made the statement that he wouldn't be surprised to learn that nicotine with sulphur was more effective than nicotine with other materials. That is so, as the result of experiments that have been carried on the past year in three different states. We never could explain just why it was so until Dr. Moore offered the explanation; we were at sea, but it is true. A weaker solution, or rather a weaker nicotine content in a dust in which the sulphur is a carrier seems to be more effective than one in which the clay is a carrier. This is merely a nicotine discussion; I am not recommending any dust.

Just one more point I have in mind here, and that is really an entomological problem and some day at the entomologists' meetings when interest lags, we might start the discussion. It is very doubtful that nicotine functions entirely in its volatile condition. It is more likely a true contact posion and does not function as a gas. That is all I want to say now; I don't want to start anything at this time.

Mr. N. J. Giddings: It was suggested by Dr. Lyman, before I gave my paper, that a word as to the activity and interest in regard to this project might not be out of place. Last year the Advisory Board of American Plant Pathologists asked me to act as leader in an endeavor to encourage coöperative work on the dusting project. In this connection a general outline or plan was sent to twenty-six states. Twenty-three of those replied, indicating that the interest was great. Eighteen states were strongly favorable toward further work in connection with dusting, and at least nine states reported experimental work during the season. Seven of them have already turned in data to me. These statements relate particularly to the pathological side. I might add that the outline was not sent generally to the South because it was rather late in the season. This is merely an indication of the interest that the dusting problem has for the whole country.

President Wilmon Newell: We have undoubtedly gained a great deal of good out of these discussions.

Adjournment.

## ARSENIC FOR GRUB-INFESTED SOILS

By J. F. Illingworth, *Gordonvale, near Cairns, North Queensland*

For some time we have been experimenting with poisons applied to the soil for the control of white grubs, since, as is well known, these pests are a serious menace to the growth of sugar-cane, particularly on the red volcanic soils in North Queensland.

Naturally our earlier experiments were in the laboratory, where the poisons were tried in small pots of soil. This was done by mixing the two together thoroughly before introducing living grubs, which by their natural process of ingesting quantities of soil inevitably absorbed some of the poison. Most satisfactory results were obtained with the ordinary crude white arsenic (arsenious acid).

By using a liberal sprinkling of the arsenic through the soil we found that the grubs all succumbed in from one to four days, and this same result was secured with each repetition of the experiment.

We now have many experiments under way in cane areas that have been regularly devastated, but it will be some time before we can hope for conclusive results, i.e. as to the amount of arsenic required per acre, method of application, etc. Hence I was glad to avail myself of an opportunity to experiment upon troublesome grubs in the garden.

During July and August, cucumbers which had been planted in hills with cowdung, failed completely. They had hardly started to grow before the leaves began to yellow, and the vines became stunted in spite of the fact that they were given an abundance of water. When they were dug out the soil was found to be filled with white grubs; and there was every indication that they had destroyed the small feeding roots. This pest proved to be *Isodon puncticollis* Macleay, commonly known as the Gauger Beetle, because of its destructive habit of digging holes into potatoes and various root crops.

I at once tried the application of arsenic to these hills, using the poison at the rate of about 80 pounds per acre, to see if it would destroy the mature grubs, leaving two hills for checks. About a fortnight later I could only find two live grubs in the four treated hills, while one of the checks had 46 and the other 21 full-grown grubs.

This result was so encouraging that I prepared six new hills on September 27th, and on October 18th, when the soil was full of newly-hatched grubs, I treated five of the hills with arsenic at the same rate, leaving one for a check. A week later, I could find no grubs in the treated hills, though two live beetles were uncovered. The check which was about six feet from the others, had 61 grubs.

An additional experiment was tried, in which the soil and dung were dusted with arsenic at the time that the hills were prepared; in this case, too, a single hill was kept for check. Three weeks later these hills were examined; six live beetles but no grubs were found in the treated hills, while numerous young grubs were in the check.

These results are most encouraging, especially since I have been able to demonstrate that the poison has no detrimental effect upon growing plants, even when used in excessive quantities, i.e. 200 pounds per acre. Furthermore I have found by careful chemical tests, prepared by the mill chemists, that sugar cane grown on land so treated takes up none of the poison—not a trace of it could be found in the juice. Growth on treated soils is most vigorous, so the only possible disadvantage may arise from the action of the arsenic upon soil bacteria, especially if we find it necessary to use the poison in large quantities. This, however, can only be demonstrated after extended application.

## Scientific Notes

**Possible use of a trap to control Leafhoppers Injurious to Fruit Trees.** During the past season in the study of flight and attraction to baits of adults of the European Corn-Borer, at Arlington, Mass., traps were used closely following the "Shaw" moth trap illustrated on Plate 54 of "The Gypsy Moth Report," 1896, by Forbush and Fernald. Instead of female moths, baits were placed in the screen cylinder in the center of the cage. These cages have the advantage of presenting twelve distinct tanglefoot surfaces to catch attracted insects.

It so happened that one of these cages containing, as an attractant, macerated grape-fruit was placed in a large apple tree severely infested by *Empoa rosae*, the rose and apple leafhopper, June 23, 1920.

Several days later this cage was completely covered with thousands of adults of the leafhopper. The trap was placed on the trunk of the tree four feet from the ground and at least three feet below the nearest foliage, so that chance may practically be eliminated in explaining the capture of the insect in such numbers.

The traps are easily and cheaply constructed. Entomologists interested in the problems of leafhoppers injuring fruit trees, may perhaps, find such a trap of assistance in the control of these insects.

GEO. W. BARBER, *Cereal and Forage Insects Division, U. S. Bureau of Entomology.*

### THE ENTOMOLOGICAL SOCIETY OF LONDON APPEALS FOR AID

The fine old Entomological Society of London, founded in 1834, and which, since 1875, has been meeting at 11 Chandos Street by the courtesy of the Medical Society of London, has, through the growth of its library, outgrown its quarters and is practically forced to move. It has bought a house at 41 Queen's Gate, South Kensington, near the Natural History Museum, and is leasing a portion of the building to the Imperial Bureau of Entomology. The cost price ot the property was ten thousand pounds, an additional sum is required for furnishing.

The cost price has been largely met by subscriptions from members, both as donations and as loans, the loans being secured by a debenture on the property and bearing five per cent. interest. After exhausting the available resources of the resident members, there still remains a sum appro imating fifteen hundred pounds, and the Society is making an appeal to foreign members, to entomologists in the dominions, and to interested entomologists in other parts of the world. Donations and loans are received by the Treasurer of the Society, Mr. W. G. Sheldon, who may be addressed at 11 Chandos Street, Cavendish Square, London, W. 1.

The London Society is the oldest of the great entomological societies excepting the Entomological Society of France which was founded a year earlier. Its Transactions and Proceedings have been largely used by American entomologists, and many of the latter when traveling abroad have been welcomed at the meetings of the Society and have cordially been given the use of the magnificent library.—L. O. H.

# JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1921

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceeding publication. Contributors are requested to supply electrotypes for the larger illustrations as far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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The high prices and urgent need of maximum production during the war stimulated to a noteworthy degree extension work, both field work and the distribution of suitable literature, and there has been by no means an over-development of this type of activity. There has not been, unfortunately, a corresponding development in providing for the publication of that type of original research which covers considerable ground and requires somewhat extensive bulletins or reports. There have been large and greatly needed developments for extended research without corresponding opportunity for publication and as a consequence, the results of many important investigations are being held until some future time. This is an unfortunate condition not only because all such data are unavailable in large measure to associated workers but on account of the reflex action it is bound to exert upon investigators, most of whom are far from well paid and rightly attach great importance to opportunities for early publication. A continuance of this condition must inevitably react upon investigation because only the most optimistic and idealistic can do their best when over-shadowed by the disheartening probability of long deferred publication. Original work is fundamental to progress along scientific lines and unless the morale of the workers is maintained by adequate provision for both study and publicity, there is bound to be more or less halting or "marking time," a deplorable condition when the urgent need of such studies is recognized. There are splendid groups of investigators throughout the country deeply interested in many problems, some of immediate and others of less direct importance and all making for unrivalled efficiency, except for the one weak point mentioned above. It is very largely as though we had a costly machine splendidly adapted to its purpose and run with a loose connection with the driving wheels, which latter, in scientific work, compare somewhat closely with adequate opportunities for publication.

# Obituary

## PROFESSOR CHARLES HENRY FERNALD

On February 22, Professor CHARLES HENRY FERNALD passed away at his home in Amherst, Mass.

He was born March 16, 1838, at Mount Desert, Maine. As a boy he assisted his father on the farm and when 15 years of age, went to sea, spending six years on vessels engaged in the West Indian and Coasting trade.

He then entered Maine Wesleyan Seminary to prepare for college, but at the opening of the Civil War, he enlisted in the Navy, where he served for three years, retiring with the rank of ensign.

His desire for an education led him to continue his studies while in the Navy and during a large part of the period, while the naval vessels were on blockade duty, he pursued, alone and without assistance, the studies which would have been assigned to him had he remained in school. This work was so thoroughly done that he was able at the close of his service, to pass the required examination in Bowdoin College, which conferred upon him the degree of M.A.

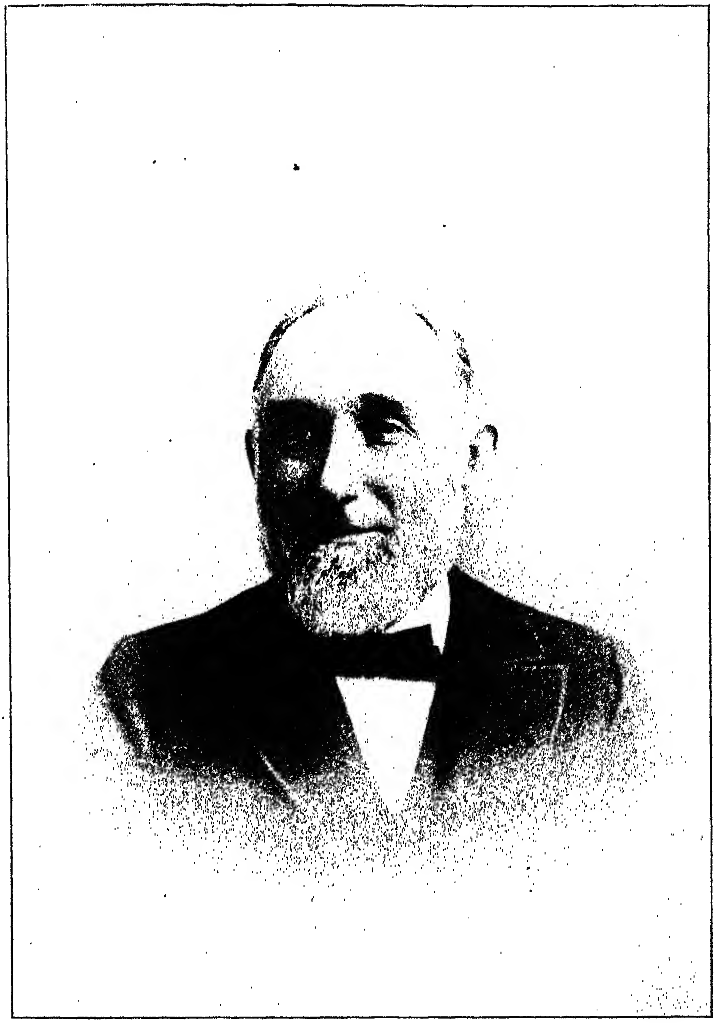
For one year he was principal of the Academy at Litchfield, Maine, and for five years at Houlton, Maine.

In 1871, he became the first professor of natural history at Maine State College, now University of Maine. During this period, he also studied in the Museum of Comparative Zoology in Cambridge, Mass., and under Louis Agassiz on Penikese Island. He also traveled extensively in Europe, studying insects in the various museums.

After a service of 15 years, he resigned to accept the position of Professor of Zoology and Entomology at the Massachusetts Agricultural College, from which he retired in 1910.

He was entomologist to the Massachusetts Experiment Station from 1887 to 1910, also to the Massachusetts State Board of Agriculture. He was acting president of the college in 1891, and later was the leader in establishing a graduate school in that institution. In 1908 he became director of the graduate school and on retiring from active service, was made honorary director.

Professor Fernald was married in August 1863 to Maria E. Smith, of Monmouth, Me., who later became well known for her work in entomology, particularly on account of the publication of the list of the Coccidae of the world. She was a very thorough student of entomology, was familiar with much of the literature on that subject, and gave unstintedly of her time and effort to assist Professor Fernald in building up a Department of Entomology in the college. She died in October 1919.



C. H. Fernald

When Professor Fernald began teaching at the Massachusetts Agricultural College, his principal lines of instruction were Zoology, Physiology, and many other subjects which had no special relation to natural history. He toiled unremittingly to build up and develop his department and being especially interested in insects, gradually succeeded in developing a department of entomology in that institution.

Beginning with no facilities whatever for the work, he succeeded in securing gradual improvement from time to time and prior to his retirement from active service, was able to see a modern, fire-proof building, constructed and equipped for class-room and laboratory work in entomology and zoology, which will now be known as Fernald Hall.

His son, Dr. Henry T. Fernald, has been connected with the institution for a number of years, and on the retirement of his father, became the head of the department.

Professor Fernald specialized particularly in Micro-Lepidoptera, a group requiring high technical skill and unlimited patience to master successfully. His published works on these insects are models of detail and accuracy. He was a member of many scientific societies and was president of the American Association of Economic Entomologists in 1896.

While all these achievements were notable, perhaps his greatest success was as a teacher. Few men who had any desire to learn or any interest in the subjects which he taught, could fail to be inspired by him. In this respect he was a master, as all of his former students will readily agree.

His kindly interest in all with whom he came in contact, will never be forgotten, and the influences for good that he exerted, not only mark him as a great scientist and teacher, but as a truly great man.

A. F. B.

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# Reviews

**The Coccidae, Tables for the Identification of the Sub-Families, and some of the more Important Genera and Species together with Discussions of their Anatomy and Life History.** By ALEX. D. MACGILLIVRAY, pages i-viii, 1-502, Scarab Co., Urbana, Ill., 1921.

This is a comprehensive, morphological, taxonomic and critical account with keys to the sub-families, tribes, most genera and a large number of species. There are also outlines of the life history in the various groups and brief discussions of the economic status of the different forms. The author has compressed within the limits of a moderate sized volume, a summation of practically 50 years of investigation and study by numerous entomologists and has succeeded in producing a work indespensable to all students of the Coccidae and one of great service to entomologists with a less direct interest in the group, because it gives within a small compass an excellent digest of available information.

The work is an outcome of 15 years of study and teaching by the author. He has in this period developed a most excellent technique and as an outcome of his studies he has been able to present a very satisfactory morphological discussion of the entire family, the sub-families, and tribes and throughout the large and varied series of forms, he has employed a nomenclature leaving little to be desired. The volume is primarily for the use of students and is somewhat technical, nevertheless the general discussions of the distribution, life history and habits of the more important groups will be of interest to many professional entomologists and not a few amateurs. Prof. MacGillivray has produced a work destined to take a worthy place is entomological literature.

E. P. F.

**Sanitary Entomology, Entomology of Disease, Hygiene and Sanitation,** edited by WILLIAM DWIGHT PIERCE, Boston, Richard G. Badger, The Gorham Press, pages I to XXVI, 1 to 518, 88 figs., 1921.

This is an exceedingly valuable, comprehensive, closely indexed resumé of our knowledge of the Entomology of Disease, Hygiene and Sanitation, which had its inception in a class formed in May 1918 among the Entomologists of the country for the purpose of studying recent developments along this line. One need only to turn to the chapter on "Flies and Lice in Egypt" to get a suggestion of the progress which has been made in most civilized countries, though present day practice is very far from what is entirely practicable, if human life and energy are worth conserving.

This book is more than a digest of current information since it embodies and summarizes the investigations and experiences of a group of experts, who have been giving special attention to the varied lines falling within the scope of this volume and at the same time have kept well posted in regard to the activities of other workers. The discovery of the part played by mosquitoes in the dissemination of disease stimulated a very considerable degree of activity, this was followed by material additions to our knowledge of the disease carrying potentialities of other species and the climax was capped by the imperative demand for the control of insect carried diseases during the war,—all summarized in this volume. The work emphasizes the possibilities of prophylaxis resulting from a knowledge of disease carrying insects and methods of controlling them. It covers, however, a broader field, since the authors of the various chapters have recognized the possibilities of further discoveries and have not hesitated to present general discussions of groups likely to be important in this connection, the main effort in this latter being to facilitate ready identifications and to outline the biology. In addition to extended discussions of mosquitoes, house flies and blow flies, fleas and lice, we find a most valuable account of the relation of insects to the parasitic worms of vertebrates, an excellent summary of the types of injury and life history of those flies producing myiasis, somewhat extended accounts of the blood-sucking flies with relation to both life histories and diseases and dissertations upon cockroaches and the diseases which may be disseminated by these pests of the home, a summary of the relation existing between mites and ticks and various diseases, accounts of animal pests and methods of control on both farm and range and a by no means unimportant feature, namely a twenty-four page tabulation of diseases and insect transmission. The exhaustive index and the well selected bibliographies make possible easy reference to original sources of information.

This volume, the product of ten experts in their respective lines should be in the library of every economic Entomologist and will be found an almost invaluable addition to Medical Libraries not only in this country but throughout the world.

E. P. F.

## Current Notes

Dr. Clarence H. Kennedy has been appointed instructor in entomology at the University of Tennessee.

Miss Florence Defiel has recently been appointed instructor in entomology at the Univeristy of Minnesota.

Professor Herbert Osborn of the Ohio State University, planned to spend most of the winter in Florida.

Mr. Otis Wade, assistant professor of entomology at the Oklahoma College and Station, resigned September 30, 1920.

Dr. L. O. Howard addressed the Washington Academy of Sciences, February 17, on "How the Government is Fighting Insects."

Mr. G. H. Gale, extension apiculturist of the Bureau of Entomology, has accepted a position with Dadant and Sons, Hamilton, Ill.

Mr. C. S. Rude has been appointed assistant entomologist at the Texas Station in foul brood inspection, *vice* W. E. Jackson resigned.

The Kansas State Beekeepers' Association held its 20th annual meeting at the Chamber of Commerce, Topeka, Kan., February 4 and 5, 1921.

The 32d annual meeting of the California State Beekeepers' Association was held at Oakland, Calif., March 2–5. There was a large attendance.

The West Virginia Beekeepers' Association held a meeting at Charleston, W. Va., March 25–26, and Mr. George S. Demuth was expected to attend.

Doctor F. E. Lutz, former curator of invertebrates, has recently been made curator of entomology in the American Museum of Natural History, New York City.

Mr. Dwight M. DeLong, Scientific Assistant, Bureau of Plant Industry, Harrisburg, Pa., left about the middle of March for a month's collecting in the Florida Everglades.

Mr. Herbert F. Schwarz has been appointed research associate in entomology in the American Museum of Natural History, New York City, and will work in the Hymenoptera.

Doctor A. E. Cameron, Entomological Branch, Canadian Department of Agriculture, resigned October 1, 1920, to accept the professorship of zoology at the University of Saskatchewan.

Mr. I. M. Hawley has accepted, effective July 1, the professorship of zoology and entomology in the Utah Agricultural College and the position of entomologist of the Agricultural Experiment Station.

According to *Science*, the department of biology of McDonald College, has been divided into two departments; botany, and entomology and zoology. The latter is in charge of Professor William Lochhead.

Mr. Arthur Gibson, Dominion Entomologist, Ottawa, Canada, has recently been appointed a member of the Advisory Board on Wild Life Protection, as a representative of the Canadian Department of Agriculture.

Mr. C. E. Smith, Bureau of Entomology, United States Department of Agriculture, stationed at Baton Rouge and co-operating with the University, is carrying on research work with truck crop insects.

In a course of lectures given at El Paso, Texas, under the auspices of the Southwestern Division of the American Association for the Advancement of Science, the subject for March 1 was "Alien Insect Enemies," by Benjamin Druckermaur.

According to *Science*, Mr. Lloyd R. Watson, assistant in apiculture, U. S. Bureau of Entomology, has resigned to accept the position of apiculturist in the Division of Entomology of the Texas Agricultural Experiment Station *vice* H. B. Parks, resigned.

Recent appointments in the Bureau of Entomology have been announced as follows: D. B. Mackie, Cal. Dept. Agr., collaborator; Elmer Johnson, temporarily transferred from Bureau of Public Roads; C. F. Doncette, Mass. Agr. Coll., Doylestown, Pa.

According to *Experiment Station Record*, Professor J. G. Griffith, head of the department of biology at the New Mexico College, and Station entomologist, resigned August 20, 1920, to accept a position in the Pasadena, Cal., High School, and was succeeded by Doctor Robert Middlebrook.

Doctor E. M. Walker, University of Toronto, for eleven years editor of *Canadian Entomologist*, retired as editor January 1st, 1921, and is succeeded by Doctor J. McDunnough, Entomological Branch, Department of Agriculture, Ottawa, Canada, to whom manuscripts for publication should be sent.

The Maine State Beekeepers' Association was organized at Auburn, Me., on February 15. L. W. Longfellow, Hallowell, was elected president, and F. L. Mason, Mechanic Falls, secretary. The first annual meeting was held March 30, at Orono, Doctor E. F. Phillips was scheduled as one of the speakers.

Mr. W. E. Anderson, State Entomologist, is employed by the Department of Agriculture and Immigration of the State of Louisiana and has immediate charge of all the State's regulatory work relating to nursery stock, the pink bollworm, citrus canker, and other insects and diseases attacking cultivated crops.

The following appointments have been announced in the Entomological Branch, Canadian Department of Agriculture: E. P. Donat, Inspector, brown-tail moth work, Nova Scotia; Gilbert Garlick, temporary junior entomologist, Vineland, Ont.; Doctor F. C. Craighead, Division of Forest Insects, Ottawa; Miss Agnes Healy, temporary clerk stenographer, Vernon, B. C.

The following transfers in the Bureau of Entomology have been announced: Perez Simmons, Alhambra, Cal., to Washington, D. C.; George H. Bradley, Mound, La., temporarily to Federal Horticultural Board; A. J. Ackerman, Bentonville, Ark., to California; C. H. Alden, Wallingford, Conn., to Fort Valley, Ga.; M. T. Young and Robert L. Saul, temporarily to the Federal Horticultural Board.

Mr. George N. Wolcott, formerly of the U. S. Bureau of Entomology and Bureau of Plant Industry studying the possible relation of insects to the transmission of mosaic disease of sugar-cane, and more recently entomologist of the Estacion Agronomica, Haina, Santo Domingo, Republica Dominicana, has severed all connection with the latter instutition and is now entomologist at the Insular Experiment Station, Rio Piedras, Porto Rico. His address is Box 1281, San Juan, Porto Rico.

At the 13th annual meeting of the Quebec Society for the Protection of Plants held at MacDonald College, Quebec, the following addresses or papers were presented by members of the Branch staff: "The Organization of the Entomological Branch," Mr. A. Gibson; "The Discovery of the European Corn Borer," L. S. McLaine; "Spraying versus Dusting," C. E. Petch ; "Chemical Investigations of Sprays," A. Kelsall. Mr. H. G. Crawford, of the Division of Field Crop and Garden Insects, also attended the meetings.

The following additions to the staft of the Japanese Beetle Laboratory at Riverton, New Jersey, have recently been made: R. W. Kelley, formerly entomologist for the Sherwin-Williams Company; A. S. Mallorey, from Rutgers College; L. B. Smith, tormerly of the Virginia Truck Experiment Station at Norfolk, Va.; T. H. Frison, of the University of Illinois. Doctor William Moore of the University of Minnesota will also carry on special work at the laboratory this season, having obtained six months' leave of absence from the University.

It was announced some time ago that Mr. T. H. Jones had been appointed State Entomologist of Louisiana. This was an error. At the Louisana State University and Agricultural and Mechanical College, Mr. O. W. Rosewall, Associate Professor of Entomology, teaches this subject, while Messrs. T. H. Jones and W. G. Bradley, Entomologist and Assistant Entomologist respectively, of the Agricultural Experiment Stations are engaged in research work, more particularly with insects injurious to corn and live stock. Mr. E. C. Davis is Apiculturist of the Extension Division of the University.

The work of Mr. C. L. Marlatt as Chairman of the Federal Horticultural Board has necessitated his relinquishment of the direction of Tropical and Subtropical Fruit Insect Investigations, and Doctor Howard has combined this branch with the office of Deciduous Fruit Insect Investigations. Mr. Marlatt will, however, maintain active co-operation in certain projects, as Mediterranean fruit fly investigations, the work under way in the Canal Zone, systematic work with Coccidae, and investigations of insects injurious to greenhouses, on account of the intimate relation of this work with certain quarantine and other work of the Board.

A conference of Hessian fly men of the branch of Cereal and Forage Insect Investigations, Bureau of Entomology, was held at the entomological field station at West Lafayette, Ind., on January 3. The persons attending this meeting were: W. R. Walton, W. H. Larrimer, A. F. Satterthwait, J. R. Horton, C. K. Fisher, R. A. Blanchard, H. R. Painter, G. B. Pearson, W. B. Cartwright, G. G. Ainslie, P. R. Myers, and C. C. Hill. It was the unanimous opinion of those present that the conference resulted in great benefit to the Hessian fly investigations, and the hope was expressed that similar meetings might be held from year to year.

At the request of the Navy Department, arrangements have been perfected for the periodic inspection of food commodities stored at the Naval Supply Base, South Brooklyn, N. Y. Doctor E. A. Back and Perez Simmons of the Bureau of Entomology recently spent two days in Brooklyn going over the situation. The accidental infestation of supplies of brown sugar by cadelle larvae and infestation of fur-lined boots, coats, and other clothing by clothes moths were the interesting features of the inspection. In the clothing department there was located a badly damaged lot of submarine boots and aviator helmets and chin protectors from which adult clothes moths were spreading, infesting the entire establishment.

The official entomologists of Ohio, Indiana, Illinois and Missouri met at Lafayette, Indiana, March 15-16, to discuss problems in their respective states, to plan the season's work and to handle results in such a way as to make them comparable.

Such important problems as the Hessian fly, chinch bug, joint-worm, codling moth, peach tree borer, potato leaf hopper, cut-worms, etc., were thoroughly discussed. Those present included S. A. Forbes and W. P. Flint, of Illinois; H. A. Gossard and T. H. Parks, of Ohio; L. Haseman, of Missouri; W. H. Larrimer, H. R. Painter, and G. B. Pearson, of the U. S. Bureau; and F. N. Wallace, H. F. Dietz, J. Troop, W. A. Price, and J. J. Davis, of Indiana. It is planned to make this conference an annual event.

Doctor T. E. Snyder, Bureau of Entomology, left Washington on January 16 for New York where a consultation with engineers of the American Telephone and Telegraph Company was held on January 17, in regard to control experiments to be conducted against the cable borer (*Scobicia declivis* Lec.). A manuscript is being prepared by members of the branch of forest entomology on this insect and the results of experiments to date. January 18 to 24 was spent by Doctor Snyder at the Museum of Comparative Zoology doing systematic work on exotic termites, particularly new Central American species. Some time was spent with Doctor C. B. Thompson at Wellesley College working on the biology and morphology of Nearctic termites.

Mr. E. H. Strickland of the Entomological Branch, Canadian Department of Agriculture, returned to Ottawa on February 4th from England, where he visited the British Museum, the Liverpool School of Tropical Medicine, and several docks and grain warehouses in connection with an inquiry regarding acarid infestation of Canadian wheat. Though mites are rarely found in grain while it is in storage in Canada, they were found in considerable numbers in parcels that had been held for some months in English warehouses. This inquiry followed arrangements which had been made with Professor R. Newstead, of Liverpool, and Doctor J. F. Birchard, of Winnipeg, for a co-operative investigation on the susceptibility of Canadian wheat to infestation by mites.

The semi-annual meeting of the Nova Scotia Entomological Society was held in Halifax on February 9th. In the absence of the President, Professor Brittain, of Truro, the Vice-President, Mr. J. D. Tothill, of Fredericton, occupied the chair. In addition to Mr. Tothill, Messrs. Sanders, Durling and Gilliatt, of Annapolis, and Keenan and Dustan, of Fredericton, were present. The following papers were presented by members of the Branch: "Our Arsenic Supply," G. E. Sanders; "Fungous Diseases as Factors in the Natural Control of Insects," A. G. Dustan; "The European Corn Borer," W. N. Keenan; "The Brown-tail Moth," F. C. Gilliatt; "Results from Spraying in 1920," V. B. Durling. In order that the Society may include as members residents in all the maritime provinces, its name was changed to the "Acadian Entomological Society."

The twelfth annual meeting of the British Columbia Entomologcal Society was held in Vancouver on February 12th, 1921. Mr. R. C. Treherne was re-elected Vice-President for the Interior district, and Mr. W. Downes Hon. Secretary-Treasurer. The following papers were presented by officers of the Branch: "A Review of Economic Entomology in B. C.," R. C. Treherne; "Notes on the Fauna and Flora of Mt. McLean," R. Glendenning; "Notes on *Amnesia decorata* and the Holly Bud Moth," W. Downes; "Forest Insect Conditions," Dr. J. M. Swaine; "Notes on the Satin Moth," R. Glendenning; "Collecting Places in northern B. C.," W. B. Anderson. Mr. Buckell gave a talk on "The Ecological Distribution of some Orthoptera from the Chilcotin district," and Mr. W. H. Lyne on "Insects Imported from the Orient." The following entomologists were also present at the meetings: Messrs. Ruhman, Venables, Blackmore, Cockle, and Day.

# JOURNAL
OF
# ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 14 JUNE, 1921 No. 3


## Proceedings of the Thirty-Third Annual Meeting of the American Association of Economic Entomologists

(*Continued*)

*Afternoon Session, Friday, December 31, 1.35 p. m.*

PRESIDENT WILMON NEWELL: The first paper is by C. H. Hadley.

## THE STATUS OF THE WORK AGAINST THE JAPANESE BEETLE[1]


By C. H. HADLEY, *Riverton, N. J.*


A year ago, a paper[2] was presented at the meeting of this association, which gave a history of the Japanese beetle[3] in this country from the time of its discovery up to that time, as well as a general statement of the several phases of the problem. During the past season, the plan presented at that time has been followed rather closely.

In the paper now presented, it is intended to discuss the present status of the work against the Japanese beetle, with particular reference to the lines of work to be followed.

### ORGANIZATION

The project is financed by the Bureau of Entomology of the United States Department of Agriculture, in cooperation with the Departments of Agriculture of the States of New Jersey and Pennsylvania. Dr.

[1]Published by permission of the Secretary of Agriculture, U. S. D. A., and N. D. A.

[2]Davis, J. J., JOUR. OF ECON. ENT., Vol. 13, (1920) No. 2, pp. 185–194.

[3]*Popillia japonica* Newm.

A. L. Quaintance, Dr. J. T. Headlee, and Prof. J. G. Sanders, respectively representing the cooperating agencies, form an advisory committee for the project as a whole, the administration of which has been assigned to the writer. Permanent headquarters in the form of an office, laboratory and storehouse are maintained at Riverton, N. J., in the heart of the infested territory.

The work has recently been reorganized along certain definite lines, as follows: Quarantine enforcement, insecticidal investigations, parasite investigations, bionomical investigations and control operations.

## Quarantine Enforcement

There now exist three quarantine orders against the Japanese beetle, quarantine No. 48 of the Federal Horticultural Board, restricting interstate movement of products, and quarantines imposed by the states of New Jersey and Pennsylvania, restricting intra-state movement of products within those states respectively. The necessary authority for nforcing the local quarantines has been delegated to the Federal authorities. The quarantine enforcement work is in charge of Mr. C. W. Stockwell, and since a paper on this subject will be presented during the session, it is not necessary to discuss it further now.

## Insecticidal Investigations

The investigations having to do with development of insecticides for this insect are being carried on by Mr. B. R. Leach and his associates. These investigations are being developed along the following lines:

(1) *To perfect an arsenical insecticide which will be a satisfactory killing agent.* As stated in the paper referred to previously,[1] the standard arsenicals ordinarily used against leaf-eating insects act as repellants rather than as killing agents in the case of the Japanese beetle. Substantial progress has been made in the development of an arsenical suitable for the purpose, and further extensive work has been planned along this line. For this purpose, a fairly complete field chemical laboratory has been equipped.

(2) *To devise methods of treating balled earth infested with Japanese beetle grubs.* The quarantine regulations prohibit the shipment of nursery stock requiring soil around the roots during shipment, except where such stock and soil is known to be free of infestation. Such

[1]Davis, J. J., 1920.

plants as evergreens and azaleas, can only be shipped in this manner. It is obviously impractical to examine such shipments for soil-inhabiting insects with any degree of accuracy, without first removing the soil, a practice which would be injurious if not fatal to the plant. An extensive series of dipping tests is in progress to develop if possible a method of treating such plants for grubs without injury to the plants.

In dealing with large shippers of the kind of stock just mentioned, any dipping method of treatment would involve so much labor and loss of time as to make such methods impractical on a large scale. An investigation has been commenced to determine the effect of vacuum and pressure on grubs and plants with soil about the roots. A large experimental outfit has been acquired, capable of an experimental range up to 28 inches of vacuum and 200 lbs. pressure. In general, tests will be planned to determine the mechanical effects of vacuum and pressure on the grub, the effect of toxic solutions on the grub in the soil under vacuum and pressure, and the effect of insoluble gases on the grub in the soil under vacuum and pressure.

(3) *Investigations to find materials suitable for killing grubs in the field.* The field cyaniding work carried on as part of the control work during the past two seasons has been expensive, and this method is hardly practical for the owner of infested territory to adopt. A series of experiments are now in operation, to endeavor to find a material less expensive than sodium cyanide suitable for this purpose, and to devise a more satisfactory method of applying such materials in the field.

## Parasite Investigations

Mr. C. P. Clausen is in charge of the parasite investigations in Japan, and although he has been there less than a year, has made substantial progress. At Riverton, a comprehensive investigation of the parasite situation in the infested districts of New Jersey and Pennsylvania is now being inaugurated. A detailed study will be made of possible native parasites or predators attacking the Japansee beetle in any of its stages, and arrangements have been made to bring to Riverton from other parts of this country certain parasites known to attack white grubs of the same relative size as the grub of *Popillia japonica.*

In view of the heavy mortality incident to the shipment of living insects from a country as distant as Japan, it seems far more practical to attempt large scale rearing for colonizing here at the laboratory, rather than to depend entirely on material coming from Japan for colonizing purposes. Mr. Clausen is now in a position to ship material

in fairly large quantities this coming season from Japan, and extensive rearing work will be undertaken at Riverton with this material.

## Bionomical Investigations

A preliminary life history study of the insect has already been made and reported on,[1] but experience has already indicated the need of a more exhaustive bionomical investigation of the insect. It is natural to suppose that an insect such as the Japanese beetle may accommodate its habits more or less to its environment, and that as it spreads, the rate and direction of the spread will be influenced by environmental conditions. Consequently a more detailed investigation of the bionomics of *P. japonica* has been commenced, taking up its life history, seasonal history, habits of flight, feeding, and reproduction, present and probable future status as a pest of our principal crops, factors influencing or limiting its geographical or climatic range, etc.

Investigations are also being conducted to determine the effectiveness of cultural methods against the insect. Farm practices now in vogue in this vicinity have failed to reduce infestation to any appreciable extent, and cultural practices commonly recommended have so far apparently had little influence on the relative abundance of the insect.

## Control Operations

During the past season a strenuous effort was made to maintain a "barrier band", as described in the paper mentioned earlier.[1] Without giving a detailed discussion of the summer's work with the barrier band, it is enough to say that while in no case did the beetle succeed in actually working through the band by its own efforts alone, it has spread to such an extent, through artificial agencies, as to make further band work impractical, within a reasonable cost. Therefore this phase of the control work will be dropped.

Roadside spraying with a repellent will be continued along the main roads running through the infested territory. Such cleanup work will be continued as may be necessary to remove heavy growth which would hinder the spraying work, and to keep the main roadsides as clean as possible, in order to minimize to the greatest possible extent the further spread of the insect during its season of flight, through the agency of passing vehicles, pedestrians, and otherwise.

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[1]Davis, J. J., N. J. Department of Agriculture Circular, 30, 1920.

[2]Davis, J. J., 1920.

In the spraying work, a strong repellent will be used, with which the vegetation will be kept coated throughout the beetle season. For practical results, it is essential that the roadside vegetation along the main traveled roads throughout the infested territory be kept in a condition as little attractive to the beetle as possible, so as to offer the least favorable conditions for the insects to feed and congregate there.

In connection with the insecticidal investigations, large scale spraying experiments will be undertaken during the coming season, for the final testing of killing agents against the beetles, in anticipation of renewed control spraying another season, if the materials tested react favorably.

## Summary

For the past two seasons, greatest emphasis has been placed on eradication or control of this insect. The work has now been reorganized more particularly along an experimental basis, looking forward to the time when active control work can again be undertaken on a comprehensive scale, with some assurance of reasonable success. In addition to the experimental work, parasite importation, breeding and dissemination will be pushed vigorously, to hasten the day when the parasites and predaceous enemies of the beetle may become an important factor in keeping the pest within reasonable bounds and comparable with other native pests. Meanwhile quarantines will be enforced as efficiently as possible, along with other restrictive measures, in an effort to delay and hinder the spread of the insect.

President Wilmon Newell: The next paper is

# THE SPREADING OF SPRAYS

By William Moore, *St. Paul, Minn.*

(Withdrawn for publication elsewhere)

Mr. C. L. Metcalf: I would like to ask how to measure the surface tension which is so important in this sort of work.

Mr. William Moore: It is hardly worth while to measure the surface tension of the liquid, since the interfacial tension comes into play. I have not given any figures of the interfacial tension because it has not been possible to measure the interfacial tension of the leaf

and spray. For surface tension I use the drop-weight method, based upon the weight of a certain number of drops. A definite volume of a standard liquid of known surface tension is run through the apparatus and the number of drops determined. This number is compared with the number of drops of the unknown liquid when the surface of the unknown may be calculated by a simple formula. In the case of such substances as casein, etc., it is almost impossible to measure because of the low speed at which the molecules of the casein are adsorbed on the surface, so that you have to allow something like one-half hour to an hour for each drop before it breaks from the tip of the apparatus. What we are interested in is not the static surface tension but the dynamic surface tension which is the one at the moment of spraying. I think that there is no doubt that we produced a film on the leaf which rolls together into a drop. What we are interested in is maintaining the film already produced.

MR. R. L. WEBSTER: I would like to ask whether there is a difference in the surface tension of soft and hard soap, for instance, oleate and potassium?

MR. WILLIAM MOORE: I suspect that the oleate would have the lowest. I think there would be a difference between the oleate and the stearate. The oleate soap would probably have a lower surface tension than the stearate soap, although I cannot give you any figures.

PRESIDENT WILMON NEWELL: The next paper is

## ECOLOGICAL OBSERVATIONS ON THE HEMIPTERA OF THE CRANBERRY LAKE REGION OF THE ADIRONDACKS

By HERBERT OSBORN, *Columbus, Ohio* and C. J. DRAKE, *Syracuse, N. Y.*

(Withdrawn for publication elsewhere)

PRESIDENT WILMON NEWELL: We will now hear the paper by Mr. Swezey.

## SOME RECENT INSECT IMMIGRANTS IN THE HAWAIIAN ISLANDS

By O. H. SWEZEY, *Experimental Station, H. S. P. A. Honolulu, Hawaii*

It is the prevailing opinion that the endemic insect fauna of the Hawaiian Islands has developed from ancestral forms which arrived as chance immigrants from elsewhere. Many of these immigrants ar-

rived a long, long time ago. Immigration, however, is a process that has continued thru the intervening time, even to the present. Many species of insects have arrived and become established in modern times, and have not yet changed so as to become peculiar to the Hawaiian Islands, but have a wide distribution to other Pacific Islands or to the continental shores of the Pacific. Much of the insect fauna of the lowlands in Hawaii is made up of such widely distributed species.

Then more recently has been the immigration in connection with human enterprises, the coming of insects in various ways thru commerce, as chance wanderers on ships, or as insect pests infesting plants, fruits, or various other foods and articles of commerce. In the latter way, many cosmopolitan pests had become established in Hawaii long before there were any attempts made to prevent it by means of quarantine inspection or other means.

For about twenty years very efficient quarantine practices have been in effect at the port of Honolulu, and many kinds of insect pests are thus intercepted which might be of serious importance should they gain entrance and become established. This constant vigilance does not entirely check insect immigration, however, and we are annually finding more new arrivals, most of which are of no importance, some are beneficial, and an occasional one proves to be injurious.

Some of the insect immigrants that have been noted most recently (1919 and 1920) are here given with notes as to distribution, habits, importance, etc. Many of the smaller ones no doubt have been present for several years and escaped notice. Unless stated otherwise, they were first observed in Honolulu.

## Hymenoptera

*Megachile* sp. [Apidae]

Specimens of this hitherto unknown bee were first captured at Mokapu, Oahu, September, 1920. None have been taken elsewhere as yet.

*Vespa occidentalis* Cresson. [Vespidae]

This American wasp was first recorded from a single female taken at Halemanu, Kauai, at an elevation of 3500 feet, by Mr. H. P. Agee, January 30, 1920. Later Mr. J. A. Kusche reported to have seen it abundant in the same region of Kauai in April, 1919. It has not been seen anywhere else in the Islands yet. It is very strange that this insect should become established first in the midst of mountain forests.

*Silaon rohweri* Bridwell. [Sphecidae]

This wasp was first reported in May, 1919, from the coast at Waianae on the west side of Oahu. In August, 1919, it was found at Ewa on the southwest part of Oahu, and in August 1920 was found in Honolulu. This tiny little wasp stores up nymphs of a bug (*Nysius* sp.). It is considered as an immigrant, possibly from Central America or Mexico.

*Itoplectis immigrans* Timberlake. [Ichneumonidae]

This Ichneumonid was first recorded in May, 1919, but from specimens collected at several previous dates, the first being 1906. It is known from Kipahulu, Maui, and widely distributed on Hawaii. It is not known from whence it came.

*Cephalonomia* sp. [Bethylidae]

A black species first collected in the Waikiki marshes, Honolulu, May, 1919, and in the Ewa coral plain June, 1919. Bred from Scolytid larvae. Source not known. It is possibly an undescribed species.

*Anagyrus antoninae* Timberlake. [Encyrtidae]

Reared from *Antonina indica* in Honolulu. First reported in July, 1919, however, it was presumably introduced with its host years ago from some part of the Orient.

*Plagiomerus hospes* Timberlake. [Encyrtidae]

Collected at Nuuanu Pali, Oahu, October, 1919.

*Anabrolepis extranea* Timberlake. [Encyrtidae]

Collected on Mt. Tantalus, Oahu, October, 1919.

*Pachyneuron anthomyiae* Howard. [Pteromalidae]

Bred from the fly *Leucopis nigricornis* in Honolulu. First recorded September, 1919.

## Diptera

*Allograpta obliqua* (Say). [Syrphidae]

First recorded in February, 1920. Found feeding on *Aphis maidis* on corn in Manoa Valley, and at the U. S. Experiment Station. Collected at Leilehua near the middle of Oahu, May, 1920; and in Olokele Canyon, Kauai, September, 1920

*Eristalis aeneus* Sapoli. [Syrphidae]

First found in Honolulu, August, 1919; at Ewa, Oahu, September, 1919; at Waianae and Manoa Valley, Oahu, October, 1919. It became very abundant at windows in houses in just a few months after it was first noticed. Its breeding habits in Honolulu have not yet been discovered, but it is thought to breed in muck or filth of some kind.

*Anthomyid fly.* [Anthomyidae]

An undetermined Anthomyid was first reported in April, 1919, at Lunalilo St., Honolulu. In May, 1920, it was found rather common in Kaimuki, a suburb of Honolulu, four and a half miles out. Its habits are not definitely known.

*Bibionid fly.* [Bibionidae]

Reported May, 1919 at Waikiki, Honolulu.

*Itonidid.* [Itonididae]

First recorded in September, 1919 at Waipio, Oahu. Later found at Ewa and Wainae, Oahu. Its larvae were feeding on *Aphis sacchari* on sugar cane, often very abundant. Its name and source have not been determined.

*Psychodid.* [Psychodidae]

An unknown black species reported common at Waikiki, Honolulu, February, 1919.

## Coleoptera

*Bruchus limbatus* Horn. [Bruchidae]

First recorded in July, 1919. Bred from seed of monkeypod tree at Waipio, Oahu. Since then it has been found generally distributed in Honolulu, and as far inland as Castner, about the middle of the Island. Besides the monkeypod, they have been found destroying the seeds of a few other related ornamental trees. This weevil occurs in the Southwestern States and Mexico.

*Calandra taitensis* Guerin. [Calandrinae]

The Tahiti coconut weevil was first found at Honaunau, Hawaii in August, 1919. During the same month and in September, it was found at other ports on the lee side of Hawaii, but could not be found on the windward side after considerable search. Apparently it has been present where found for a number of years, but has escaped notice. It is not harmful to the trees as the larvae feed only in the edges of the leaf stalks near the base, and the trees where they were the most numerous were flourishing better than one ordinarily sees. It has not yet been found on any of the other Islands.

*Stennomatus musae* Marshall. [Cossoninae]

This weevil was first found in a garden at Kaimuki, a suburb of Honolulu, February 19, 1920. Larvae, pupae and adults were numerous in a decaying banana stump or corm. They have not been found elsewhere as yet. It is a very small species of Cossonid, and has been named as a new species by Dr. Guy A. K. Marshall, the description to be published soon.

*Trogoderma* sp. [Dermestidae]

This Dermestid was first reported in Honolulu in October, 1920, from having been found breeding in large numbers in a box of packages of miscellaneous garden seeds that had remained undisturbed for some months. Specimens were later found in collections dated May and October, 1919. It is probably American, tho the species has not yet been determined.

*Nitidulid beetle.*

Recorded October, 1919, from Haleakala, Maui

*Clerid beetle.*

Recorded November, 1919, from dead wood, Honolulu.

## HOMOPTERA

*Aphis middletonii* Thomas. [Aphididae]

First identified and recorded in December, 1919, on the roots of *Coreopsis* and China aster, but known to have occurred on asters as early as 1910.

*Thoracaphis fici.* [Aphididae]

First recorded June, 1920, but had been previously collected in March, 1918.

*Coccus acutissimus* Green. [Coccidae]

First recorded in March, 1920, on litchi, but has probably been present for a long time.

## ORTHOPTERA

*Teraiura* sp. [Locustidae]

First collected at Hilo, Hawaii, July 25, 1919, at lights. It has been on the increase there since, but its habits have not been learned as they are found only when coming to lights, and females only.

NEUROPTERA

*Chrysopa* sp. [Hemerobiidae]

A species similar to the American *Chrysopa externa* Hagen. First recorded in November, 1919, but examination of collections shows its presence as early as 1914. It is known on Maui as well as Oahu. The larvae feed on various kinds of plant lice.

Single or few specimens have been taken of a number of other foreign insects under circumstances not conclusive of their being established. For example: *Apion* sp., *Scypophorus* sp., a Cerambycid, a Malachiid and a Bostrychid.

Twenty-six species are above enumerated, as per records in the Proceedings of the Hawaiian Entomological Society. These species are distributed in the Orders as follows: Hymenoptera 9; Diptera 6; Coleoptera 6; Homoptera 3; Orthoptera 1; Neuroptera 1.

MR. A. H. ROSENFELD: I would like to ask if burning of sugar cane trash is general in Hawaii, and if so, what effect it has on the parasites?

MR. O. H. SWEZEY: The burning of trash is general before sugar cane is harvested, and in almost the entire cane district fire is run through the fields to burn the trash and facilitate harvesting. We believe it has no effect upon the parasites of insects pests, for the reason that in all cases there are sugar cane fields growing in all stages from very small to mature cane, and the pests and parasites, if present, have migrated to these different fields and become established. Parasitism is well under way before a mature field is burned off in the process of harvesting.

MR. L. O. HOWARD: I was told that there was a case in the summer of 1915 when a leafhopper outbreak on the Island of Oahu was said to be due to burning of trash and the destruction of the parasites.

MR. O. H. SWEZEY: There has been injury in this way at times to isolated fields, but in general the damage to parasites by burning fields is as I previously stated.

PRESIDENT WILMON NEWELL: The next is by W. H. Larrimer.

# GRASSHOPPER AND CRICKET REPELLENTS[1]

By WALTER H. LARRIMER, *Scientific Assistant, U. S. Bureau of Entomology, West LaFayette, Indiana*

[1]Published by permission of Secretary of Agriculture.

Much has been done to secure a bait with which to poison grasshoppers and crickets and as evidence of creditable results obtained, we have poison bran mash with various attractive agents enough to suit the conditions of most any locality as well as the fancy of any particular entomologist.

For several years there has been much trouble experienced by farmers in widely separated localities from grasshoppers and crickets cutting the bands of the sheaves while the grain is in the shock. In the case of grasshoppers this trouble could be prevented by poisoning the -nsects in question before the grain is cut but unless this procedure were practical for other reasons a more suitable remedy is to be desired. Since so much effort seems to have been necessary to secure a suitable attractive poison bait, it would naturally be expected that a suitable repellent could easily be found which might be applied to binder twine to prevent this damage. Since records on this subject are so rare and brief in Orthoptera literature, it seems desirable to include here all references which can be found.

Criddle. Report of Canadian Experimental Farms 1884-1904. Report of Entomologist, 1903. Page 174.

"Some damage was caused from locusts eating binder twine; very few had bluestoned the twine, and we have now been able to demonstrate without a doubt that some brands of binder twine are much more subject to attack than others. Whether it is that certain brands are made of different materials or that they are looser than others, I cannot say; but the twine which was most attacked is very loosely twisted."

Howard. U. S. D. A., Div. Ent. Bul. No. 30, page 94.

"Insect injury to binding twine:- We have received several complaints of injury by crickets and grasshoppers to binding or binder twine, which we are informed is used for stacking small grain in the field, a remedy or preventive being desired. During May 1901, Mr. I. D. Sheaffer, Russell, Kansas, and Miss Annette Bowman, Moscow, Idaho, wrote in regard to such injury. These are only two of several complaints. In no cases have we received specimens of the insects, nor have we been able to suggest any substance that would kill the insects or deter them from attacking the twine that would not at the same time be dangerous to those handling it. Poisons, of course, could not be used, and sticky substances would also be objectionable, although of course, they would prevent injury by the insects."

Gibson & Criddle. Canadian Department of Agriculture. Crop Protection Leaflet. No. 6. Page 3.

"Damage to Binder Twine In the Prairie Provinces considerable injury, some years, has been caused by locusts, as well as crickets, eating binder twine

when grain is standing in stocks. Some kinds of twine, as for instance thrt which is loosely twisted, has been more attractive to insects. We have used several mixtures to protect the twine from locust injury and the following has been found most useful.

| | |
|---|---|
| Bluestone . . . . . . . | 1 pound |
| Water . . . . . . . . . . | 6 gallons. |

The balls of binder twine should be soaked in the solution for half an hour, and then dried thoroughly before using. The mixture, of course, is not intended to destroy locusts: it simply acts as a deterrant."

Washburn. Minn. Agric. Expt. Station. 1903. Press Bulletin No. 16, page 6.

"To prevent crickets and grasshoppers from eating binder twine in the fields: Soak balls of twine in a solution of 2 lbs. bluestone dissolved in 12 gallons of water, for half an hour and then dry it thoroughly. (H. Vane, in Canadian Report.)

It must be remembered that it is hard to dissolve bluestone; it should therefore be placed in the water quite a long time before the liquid is to be used.

A farmer here suggests soaking balls of twine in kerosene. This might be effective."

Being unable to locate the vague reference to Mr. H. Vane, the following explanation is offered through the courtesy of Mr. Criddle in a letter of recent date.

"The experiments conducted by Mr. H. Vane were undertaken with a view to protecting the binder twine from the ravages of locusts. Several substances were tested, including coal oil and salt, but the only one giving immunity was from soaking the balls of twine in a solution of Bluestone (Copper sulphate) and water.

I may say that the Bluestone solution was used by many of us and proved very satisfactory excepting for the fact that it had a tendency to weaken the twine. We found also, that it tended to clog in the binder but that it worked much better when thoroughly dried.

Mr. Vane is a farmer of these parts and has not published any information on the above subject."

During the past season, in order to obtain further information on this this subject, a series of experiments was conducted in which one to two hundred sheaves were bound in the usual manner, with each of the several variously treated twines and exposed naturally in the field. A similar test was run in each of six widely separated localities from which trouble of this sort had been reported the previous season. Just before threshing, an examination was made for cut bands and not a single band was found cut in any locality, even of the untreated twine used as a check.

It was then decided to carry out some elimination experiments by some other method to determine if possible which of the ordinary repellents would probably be best for actual field application. The method of determining the relative value of the various repellents used was the same as described by Larrimer and Ford in a previous paper

on "Observation on the Attractiveness of Materials used in Grasshopper Baits." Small amounts of wheat bran were treated with the various repellents, these samples were exposed under natural conditions in the field, and the crickets and grasshoppers observed within six inches of the bran or feeding upon it, were recorded. In all cases the various samples were run in duplicate and interchanged frequently so that any variation of results might not be due to advantage of location. A pair of field glasses was used to make the counts since, by this method, accurate counts could be made with the observer stationed twenty or thirty feet from the bran samples and thus not disturb the crickets or hoppers which were being counted.

In choosing the following materials as fairly representative of the various groups of the common repellents, the availability and cost was of course an important consideration. Soap, gasoline, sulphur, aloes, creosote oil, furniture polish, nitrobenzine, nicotine sulphate, auto oil, kerosene and copper sulphate were each mixed with small samples of wheat bran and these exposed in the center of card board discs twelve inches in diameter and cross marked with black lines to facilitate counts. These discs were placed in a tract of uncultivated land grown up to weeds, uniformly but not heavily, infested by grasshoppers and crickets.

*Melanoplus femur-rubrum* was by far the predominating species of the grasshoppers present but some *M. atlanis*, *M. differentialis*, *Dissosteira carolina*, *Encoptolophus sordidus*, *Scudderia furcata*, *Orchelimum vulgare*, and a species of *Conocephalus* were also taken.. The species of crickets taken in the counts were *Gryllus assimilis pennsylvanicus* and *Nemobius fasciatus*. Wet bran was used as a check and since black strap molasses has been found to be one of the best attractive agents, samples of bran treated with the standard strength of this material were included as an additional basis of comparison.

The bran samples were moistened with the various materials mixed in the following strengths. The liquid repellents, black leaf 40 excepted, one part repellent to four parts water; powdered aloes or sulphur, one tablespoonful to one pint water; copper sulphate, a saturated solution in water; black leaf 40, one tablespoonful to one pint of water; soap, either Ivory or fish oil, as strong a solution as possible in cold tap water. It was not practical to run all of the materials at one time, but four seres were run on the following inclusive dates Series 1, August 23 to 25; Series 2, August 31 to September 1; Series 3, September 21 to 22; Series 4, October 5 to 8.

In Series 1, fresh samples were used for August 23 and 24 and those

used on the 24th were left in position over night and used on the 25th. In series 2, 3, and 4, the original samples used on the first day of each series were left in position at night and run for the entire period. The total number of crickets and grasshoppers for each material and each series is indicated in Table 1.

Table I.

| | Crickets | | | | Grasshoppers | | | |
|---|---|---|---|---|---|---|---|---|
| Series | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| Soap | | 743 | 64 | 225 | | 364 | 829 | 881 |
| Black Strap | 1667 | 286 | 12 | 118 | 593 | 243 | 232 | 503 |
| Water | 922 | 203 | 10 | 137 | 609 | 214 | 348 | 392 |
| Gasoline | 948 | | | | 499 | | | |
| Sulphur | | | | 145 | | | | 347 |
| Aloes | | 370 | 13 | | | 161 | 191 | |
| Creosote Oil | 1031 | | | | 390 | | | |
| Furniture Polish | 780 | | | | 427 | | | |
| Nitrobenzine | | | 6 | | | | 133 | |
| Nicotine Sulphate | | 175 | | 66 | | 155 | | 161 |
| Auto oil | 573 | | | | 347 | | | |
| Kerosene | 345 | 146 | 6 | 31 | 372 | 193 | 72 | 160 |
| Copper Sulphate | | 68 | 3 | 10 | | 157 | 32 | 70 |

The most remarkable feature of the whole experiment is not the discovery of a first rate repellent but the relative unconcern with which both crickets and grasshoppers ate the bran even when heavily treated with materials commonly regarded as repellents and especially the almost unbelievable fondness shown for soap. This is shown, not only by the record of counts made, but was especially noticeable while the experiment was in progress. In the case of Series 4, practically the entire sample of bran treated with soap was consumed by the end of the fourth day. This peculiarity of taste was noted as soon as soap was added to the series and subsequently extreme care was taken to make sure that it was the result of an actual liking for the soap and not due to a possible slip in technique. It might be stated that a later field test proved the value of soap not only as an attractive substance when used in the preparation of poison mash but by its use as an ingredient, the mechanical condition of the mash was improved considerably.

To determine the effect of soap on the hoppers when no poison was used, one lot was confined in a screen cylinder cage and fed green corn and bran treated with soap. A check lot was fed on green corn alone and the death rate in the check was more rapid than in the case of the soap fed lot. Another season it is intended to give this a thorough test and also determine if possible, just what ingredient of soap is so attractive.

As for repellents, the copper sulphate is easily the most promising, kerosene coming second. It was noted during the progress of the experiment that while some few hoppers and crickets were counted near or on the bait treated with copper sulphate, it was very rarely indeed that any feeding was done. This was also true to a less extent in the case of kerosene.

By a comparison of the counts and influenced somewhat by the behavior of the hoppers as otherwise noted during the progress of the experiment, the various materials can be listed in order of their repellent qualities, as follows, the most repellent being placed last: soap, black strap, water, gasoline, sulphur, aloes, creosote oil, furniture polish, nitrobenzine, nicotine sulphate, auto oil, kerosene and copper sulphate. Since the first three and the last two mentioned were run in three series together, it is interesting to note the total results as shown in Table II.

Table II

| | Crickets | | | | | Grasshoppers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Series | Soap | Black Strap | Water | Kerosene | Copper Sulphate | Soap | Black Strap | Water | Kerosene | Copper Sulphate |
| 2 | 743 | 288 | 203 | 146 | 68 | 364 | 243 | 214 | 193 | 157 |
| 3 | 64 | 12 | 10 | 6 | 3 | 983 | 244 | 348 | 78 | 35 |
| 4 | 225 | 118 | 137 | 31 | 10 | 881 | 503 | 392 | 160 | 70 |
| Total | 1032 | 418 | 350 | 183 | 81 | 2228 | 990 | 954 | 431 | 262 |

MR. J. J. DAVIS: In connection with the attractiveness of soap to grasshoppers, it may be of interest to state that Mr. Leach, who has been working with insecticides for the control of the Japanese beetle, has found that soap added to arsenate seemingly has an attraction for that insect.

PRESIDENT WILMON NEWELL: The next paper is by T. J. Headlee.

# THE RESPONSE OF THE BEAN WEEVIL TO DIFFERENT PERCENTAGES OF ATMOSPHERIC MOISTURE[1]

By Thomas J. Headlee, Ph.D., *New Brunswick, N. J.*

Since the publication of "Some facts relative to the influence of atmospheric humidity on insect metabolism"[2] the writer has, as time would permit, collected data on the response of the bean weevil, *Bruchus obtectus*, to varying degrees of atmospheric moisture ranging in stages from less then 1% to approximately 100%. He has now completed three distinct sets of experiments and the curves, which are presented, have been constructed on the basis of the average of the experiments.

As in his previous experiments of this sort the utmost care has been taken to eliminate variable factors other than atmospheric moisture. The insects have been kept throughout their life cycle in darkness and and they have been subjected to a constant temperature of 80° Fahr., which did not vary as much as a degree either way. The pull of the water pumps has been approximately sufficient to counteract the changes in barometric pressure.

In each set of experiments the adult weevils were taken from exactly the same sources.

In each of the three series of experiments five containers were employed for each selected percentum of atmospheric moisture. Each of the five containers received twenty-five adult beetles as nearly evenly divided between the sexes as was practicable. Thus each selected percentum of atmospheric moisture in each of the three sets of experiments started with one hundred and twenty-five (125) adult weevils. The succeeding progeny in the five containers ranged from nothing in very low atmospheric moistures to over 1200 individuals in more favorable atmospheric moistures. The factor of individual variation in response was in this way reduced to the lowest practicable minimum.

The means employed to condition the atmosphere has not, it is thought, been heretofore considered in a formal way. The air was taken from outside of the building and led through a rubber pipe to a concentrated sulphuric acid drier. From thence the air stream was led into a distributing bottle from which each of the lines for the particular selected percentum of atmospheric moisture took their rise. One line led directly into an experimental chamber which was held at a constant temperature of 80° Fahr., and passed directly through the group of five containers in which the beetles and later their progeny

[1]Paper 17 of the Technical Series, N. J. Agricultural Experiment Stations, Department of Entomology.

[2]Journal of Economic Entomology, Vol. X, No.1, 1917.

were raised. This line then left the experimental chamber and passed over to the sink, where it was connected with a constantly functioning glass suck pump. The other lines, all of which contained air that must receive further conditioning as to atmospheric moisture, passed into different experimental chambers, all of which were held at a constant temperature of 80° Faнr., where the air was led through concentrated aqueous salt solutions; each stream passing through the particular salt solution which gave to it the desired amount of atmospheric moisture. Each line was then led to its particular group of five containers in which the beetles and their progeny were living. From the containers each air stream was led by a separate pipe to the sink, where it was joined to its own particular glass suck pump. The one in which the air must be conditioned to approximately 100% atmospheric moisture was led through a flask of distilled water and thence to its group of five containers.

The writer has tried various methods of conditioning the air, such as: (1) constantly raising the atmospheric moisture of the experimental chamber by the introduction of sponges or wet cloths and holding the percentum of moisture desired by passing the air over calcium chloride as often as it rose above the desired percentum; (2) passing moisture laden air through low temperatures and then passing it into a chamber, the temperature of which bore such relation to the previous low temperature that the percentage of atmospheric moisture was such as was desired. The first method is unsatisfactory, because there was no provision by means of which the air could be changed with suffiicient rapidity to maintain the normal equilibrium of its component gases, especially as regards the proportion of carbon dioxide. The second method is ideal, but involves so large a quantity of expensive apparatus as to render it impracticable.

In view of the, to him, insurmountable objections to the two methods just described his attention was directed to the possibilities of utilizing the different vapor tensions of various aqueous salt solutions. He found no difficulty whatever in obtaining data on the vapor tensions of different aqueous salt solutions, but, in view of the fact that none of the vapor tension data were derived from saturated aqueous solutions, and in view of the further fact that without saturation the maintenance of a constant concentration was apparently out of the question, it became necessary to determine the amount of moisture which the different saturated aqueous solutions of various salts would give off under a constant temperature. Inasmuch as the machines with which he was workingwere well adapted to the maintenance of a

constant temperature of 80° Fahr., he determined to secure data on saturated aqueous solutions of various salts at that temperature. Accordingly a chemist was secured to make the determinations.

Data were obtained on the following salts:- sodium chloride, sodium bromide, barium chloride, lithium chloride, potassium sulphate, calcium chloride, aluminum chloride, potassium chromate, copper nitrate, sodium phosphate, sodium nitrate, sodium hydroxide and strontium chloride. With this at hand he selected from the group the following salts:- lithium chloride giving 7.1% atmospheric moisture: calcium chloride giving 25.9%; sodium hydroxide giving 30.7%; aluminum chloride giving 37%; copper nitrate giving 45.7%; sodium bromide giving 56.1%; sodium chloride giving 73.4%; sodium nitrate giving 80% and potassium sulphate giving 89.7%. The air as it came directly from the concentrated sulphuric acid drier contained less than 1% of atmospheric moisture, and the air which was passed through distilled water contained approximately 100% atmospheric moisture.

The length of time necessary for certain transformations to take place was adopted as the measure of the response of the bean weevil to these varying percentages of atmospheric moisture. It was thought to be impracticable to check this type of measure by the measurement of the evolution of carbon dioxide, because the food of the insect, being a living plant, threw off considerable quantities of carbon dioxide on its own account and obscured the evolution of that gas from the insects under observation.

Two curves were derived; the first representing the period of time from the laying of the egg to the formation of the pupa, and the second representing the period of time from the laying of the egg to the emergence of the adult. The first curve has proven to be very smooth and definite, while the second curve shows very pronounced variations. No individuals succeeded in reaching maturity in an atmospheric moisture of less than 1%, and very few individuals succeeded in an atmospheric moisture of 7.1%. Comparatively few succeeded in reaching maturity in an atmospheric moisture of 25.9%. In these three cases the only apparent cause was the low atmospheric humidity. In both 89.7% and approximately 100% in spite of everything that could be done in the way of sterilizing the food, fungi developed and always greatly reduced the number, and in some cases, utterly prevented the insects from reaching maturity. Such as did reach maturity in the

100% atmospheric moisture seemed to be considerably delayed, possibly by the action of the fungi. The data from these sets of experiments, as those derived from previous ones, indicate that the optimum atmospheric moisture for the bean weevil lies somewhere between 80 and 89%, and is located in that percentum which is just far enough below 89 to prevent the development of injurious fungi.

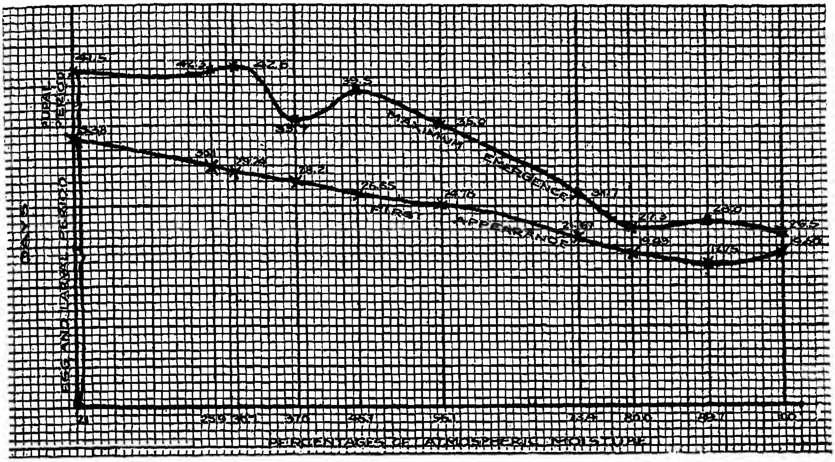


FIG. 5 Chart showing effect of atmospheric moisture in the development of the Bean Weevil.

As is shown by the curve based on the length of period from egg to pupa, the value of 1% increases in atmospheric moisture at any point between 7.1% and 80% is approximately two-hundredths of a day. Of course, there is considerable variation in this evaluation of the 1% increase, but the variation is such as to indicate that that figure is not very far from the facts. The variation is thought to be due in all probability to the direct and possibly to the indirect effect of certain of the salts which seemed, in some cases, to have a retarding, and in other cases to have an accelerating action. These variations as shown in the curve representing the period from egg to pupa became much more pronounced in the curve representing the period from egg to adult. As yet the writer has had no opportunity to evaluate this factor, and consequently has not been able to smooth the curves. The curve representing the period from egg to adult cannot be considered as representing in a satisfactory manner the effect of the different percentages of atmospheric moisture until it has been smoothed in that way. Nevertheless, the writer believes that it is fair to assume that the curve representing the period from the egg to pupa is already sufficiently

smooth to give a pretty accurate idea of the effects of the different percentages of atmospheric humidity on the rate of developmont of this insect.

As the next step in this investigation, it is proposed to evaluate the retarding and accelerating effect of certain of these salts and to check the measuring stick used in these sets of experiments by the carbon dioxide index.

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MR. R. N. CHAPMAN: I should like to ask Mr. Headlee about the moisture content of the beans. In trying some experiments with the bean we found that the bean seemed to act as a buffer medium. The bean would have to come into equilibrium with the vapor tension of the air and the larvae would come into equilibrium with the moisture content of the bean. The moisture content of the bean would depend upon how many larvae there were present. While in a general way you get this effect which shows very nicely in these curves, in any particular instance you couldn't be sure of what would happen because it depended upon the number of larvae that happened to be present in the particular bean. Therefore, I have resorted to some insects which lived free in food like many of those working in stored food products. Before the larvae enter the bean they are pretty small, and when they are exposed to the lower percentage of humidity the death rate is very high. I presume you found the same thing.

MR. T. J. HEADLEE: I attempted to meet the variables you mention by using large numbers of insects and averaging results. Inasmuch as the three extensive series seemed to agree among themselves I felt that we were not very far off in spite of the difficulties which you have mentioned.

MR. R. N. CHAPMAN: Your curve shows that your results check very nicely. That is the best proof.

I should also like to ask you a question about your saturated solutions of salt. When we tried them out with small volumes of air they seemed to work very nicely. Then we tried them with larger volumes, using a combination pressure and volume blower which would give us a displacement of about sixteen inches of water, and we tried to run through about two hundred cubic feet of air, we found that we couldn't do it. Of course, I presume the whole secret of it is that up to a certain point the ratio of air to moisture and the fineness into which you can divide your air to pass it through is going to control the rate at which the air and moisture come into equilibrium.

MR. T. J. HEADLEE: Your explanation seems reasonable.

MR. R. N. CHAPMAN: Do you know how large a volume can be passed through this, and at what rate?

MR. T. J. HEADLEE: No. I have not tried to work it out. I have used as high as 5 liters in 10 minutes; that is, a liter every two minutes

PRESIDENT WILMON NEWELL: The next paper is by J. L. Horsfall and J. R. Eyer.

## PRELIMINARY NOTES ON CONTROL OF MILLIPEDES UNDER SASH

By J. L. HORSFALL and J. R. EYER, *State College, Penna.*

In the fall of 1910, truck growers in eastern Pennsylvania experienced severe losses from the depredations of millipedes. One grower lost his entire stand of carrots and fifty per cent of his stand of lettuce grown under sash. Two problems presented themselves: one, the prevention of injury to lettuce in the fall as the seed was germinating; two, the prevention of injury to growing tomato seedlings in the spring.

### CONTROL BY SOIL FUMIGANTS AND CONTACT PREPARATIONS

EEFFECT ON MILLIPEDES:- In tables I and II the data were obtained from cold frames seeded to lettuce in the fall. All plots comprised an area of 48 square feet. From table I it will be seen that sodium cyanide at the rate of 150 pounds to the acre, when sprinkled in furrows and covered, resulted in an increase of 256 plants as compared with the check plot. The slight increases in stand in plot 1c and plot 1d can hardly be attributed to control of millipedes in view of the fact that these pests damaged the outer rows in all the check plots to a greater extent than they did the center rows. Since the increased number of plants in plot 1c and plot 1d were found in the center rows while the side rows had the same stand as those in check plot 1, it is clear that control was lacking. No control was obtained in plots treated with creosote oil, diluted either 1 - 25 or 1 - 50, or with cresylic acid 1 - 100. Creosote oil 1 - 100 and cresylic acid 1 - 200 gave some control but this was small when compared with results obtained with cyanide. At the time the counts were made, living millipedes were common in all the plots treated with creosote oil and cresylic acid while few were found in the cyanide plots.

Two of the treatments applied the day seed was drilled resulted in a decided retardation of millipede activities as shown in table II. On

Table I—The Effect on Millipedes of Soil Fumigants and Contact Insecticides Applied One Week Before Seeding

| Plot No. | Materials | Strength | Amt. used per plot | No. plants in stand Side rows | Center rows | Total | Manner of application |
|---|---|---|---|---|---|---|---|
| | | Lb. per Acre | Gal. | No. | No. | No. | |
| 1 | Check | | | 192 | 288 | 480 | No treatment |
| 1a. | Sodium cyanide | 150 | 7½ | 320 | 416 | 736 | Sprinkled in furrows and covered at once |
| 1b. | | 250 | 7½ | 128 | 192 | 320 | Ground cultivated before seeding. |
| 1c. | | 150 | 15 | 176 | 336 | 512 | Sprinkled over surface of soil. Raked over within 42 hrs. |
| 1d. | | 250 | 15 | 192 | 320 | 512 | Ground cultivated day before seeding. |
| 2 | Check | | | 64 | 320 | 384 | No treatment |
| 2a. | Creosote oil | Dilution 1-25 | 15 | 0 | 192 | 192 | Sprinkled over surface of soil |
| 2b. | | 1-50 | 15 | 160 | 160 | 320 | Raked over within 24 hours. |
| 2c. | | 1-100 | 15 | 192 | 224 | 416 | |
| 2d. | Cresylic acid | 1-100 | 15 | 0 | 128 | 128 | Ground cultivated day before seeding. |
| 2e. | | 1-200 | 15 | 128 | 320 | 448 | |

Table II—The Effects on Millipedes of Soil Fumigants and Contact Insecticides Applied at Time of Seeding

| Plot No. | Materials | Strength | Amt. used per plot | No. plants in stand Side rows | Center rows | Total | Manner of application |
|---|---|---|---|---|---|---|---|
| | | | Gal. | No. | No. | No. | |
| 3 | Check | | | 160 | 320 | 480 | No treatment |
| 3a. | Creosote oil | 1-200 | 15 | 0 | 64 | 64 | Sprinkled over surface of soil after seeding |
| 3b. | Nicotine sulphate | 1-200 | 25 | 384 | 320 | 704 | Lime broadcasted worked into soil before seeding. Solution sprinkled over surface of soil after seeding. |
| 3c. | Sodium Cyanide | 150 lb. per A. | 20 | 0 | 4 | 4 | Sprinkled over surface of soil after seeding. |
| 4 | Check | | | 160 | 416 | 576 | No treatment |
| 4a. | Nicotine Sulphate Hydrate Lime Dust | 2% Nicotine | lb. 1¼ | 240 | 480 | 720 | Scattered in row with seed. |

plot 3b where nicotine sulphate was applied, there was an increase of 224 plants over the stand on check plot 3. Attention is directed to the even stand in both center and side rows of the plot which received this treatment. There was also a decided gain on plot 4a. This section was treated with a 2 per cent nicotine dust made by sprinkling nicotine sulphate on hydrated lime.

Effect on Germination:- Sodium cyanide at the rate of 250 pounds to the acre, as used on plot 1b, did not prevent germination but checked it to some extent. Where used at the same strength on plot 1d the cyanide caused no injury, which was due to the difference in method of application. Creosote oil 1 - 25 and 1 - 50 and cresylic acid

1 - 100 gave distinct injuries as compared with the stand on a check plot 2. Creosote oil, table II, when diluted 1 - 100, showed a strong tonic action on the germination of the seeds. The same was true on plot 30 on which sodium cyanide was used at the rate of 150 pounds to the acre. The reason for this was that the chemicals came in direct contact with the seed. An examination of plots 3, 3a, 3b, and 3c eight days after the several treatments were applied showed that the surface soil of the treated plots had become caked, thus preventing the plants from breaking through the soil. A comparison of these plots with their check, number 3, where the stand was already showing, indicated the necessity of loosening the crust. The soil over the seeds was raked by hand and an almost perfect stand resulted on plot 3b, as shown in table II.

Naphthaline flakes, either applied as a dust in the row, or mixed with hydrated lime and broadcasted immediately before sowing, was a check on the germination of the seeds. This treatment had a distinct value as a repellent to the millipedes. The soil, however, where the naphthaline was used, became dry. This condition was undoubtedly a factor in low seed germination. Limed and unlimed check plots provided comparisons with regard to this condition. Various other materials were tested but these gave no control.

## Control by Poison Bait

Spring Treatment:- In the spring of 1920, a tomato grower complained that millipedes were damaging seedlings under sash. The pests were cutting the tomato seedlings at the surface and feeding on a portion of the root system. Arrangements were made to test the effectiveness of poison baits as usually recommended for these pests. The various baits were scattered in handfuls over the surface of the ground between the plants and adjacent to the sides of the frames. Observations showed that the millipedes fed upon all of the mixtures, while attacks upon the tomato seedlings ceased. The most satisfactory formula was composed as follows:

| | |
|---|---|
| Bran | 2 pk. |
| Molasses | ½ - 1 pt. depending on quality. |
| Sodium arsenite | 2 oz. |

Water, in sufficient quantity to make mash.

Fall Treatment:- In the autumn of 1920, the above formula was again tried on lettuce beds under sash. The bait was scattered over the surface of the soil in one series and in another test was placed either under boards or in furrows along the edges of the cold frames, after-

ward being covered with soil. These experiments resulted in no control. The apparent contradiction of these results was due to seasonal habits rather than to the ineffectiveness of the poison. In the spring the millipedes were becoming active after hibernation and fed ravenously on the tender plants at the surface. In the autumn, the pests, going deeper into the soil to pass the winter, were not attracted to the growing plants above the surface. Consequently, when bait was applied in the spring, they were readily attracted, while applications in the fall seeded frames proved inefficient.

## Summary

Either sodium cyanide, nicotine sulphate solution, or nicotine sulphate in the form of a dust resulted in comparatively perfect stands of lettuce.

The plot treated with sodium cyanide at the rate of 150 pounds to the acre, when applied in furrows and covered with soil one week before planting, showed an increase of 256 plants over the untreated plot.

Nicotine sulphate, diluted one part in two hundred parts of water, when sprinkled on a newly seeded bed, resulted in an increase of 224 plants as compared with the check. This plot had been previously limed, but as shown in the other tests, lime did not factor as a control measure.

Two per cent nicotine sulphate as a dust increased the stand 144 plants.

Sweetened poison bait controlled millipedes in the spring but proved inefficient in autumn as a protection in fall seeded frames.

Mr. E. C. Cotton: Was the same amount of seed used in each case?

Mr. J. L. Horsfall: The seed drill was set exactly the same in the treated plots as it was in the checks.

President Wilmon Newell: The next paper is by F. M. Wadley.

# LIFE HISTORY OF THE VARIEGATED CUTWORM[1]

By F. M. Wadley, *U. S. Bureau of ontomology*

The variegated cutworm[2] is distributed over most of North America and the rest of the world. Its power of sudden increase to de-

[1]Published by permission of the Secretary of Agriculture.

[2]*Lycophotia margaritosa saucia* Hbn.; family Noctuidae; order Lepidoptera.

structive numbers, together with its voracious appetite for nearly all crops, have made it a dreaded pest. The developmental stages have been well described and figured by various workers.

The work on which this article is based was done by the writer while a field assistant with the federal Bureau of Entomology, Truck Crop Insect Investigations, at Wichita, Kansas, in 1915. Some data has been drawn from work done by Mr. F. B. Milliken, with the writer's assistance, in 1914, at Garden City, Kansas; and from notes of occurrence made at various times by Mr. Mililiken and the writer.

The larvae were reared in the insectary in jelly glasses, in which soil had been placed, and were fed various kinds of green leaves. The adults were kept in cloth-covered cages outdoors, and given sugar-water and alfalfa blossoms. Eggs were deposited on the cloth of the cage, and could be clipped off or allowed to hatch in place. The season of 1915 was unusually cool. that of 1914 about normal.

## Development

Egg. The egg is hemispherical, a little less than 1 millimeter in diameter, and is a clear, pale yellow when first deposited, changing to brown by the second day and darkening slowly thereafter. Some egg masses, presumably unfertilized, fail to show this color change. Of about 3,000 apparently normal eggs observed, 75% hatched, different egg masses varying from 7 to 100% fertility.

In hot weather eggs will hatch in 4 days. In 1915 the average was 5.2 days, varying from 4 to 6 days. In May, 1914, 7 days were required. Eggs in a single mass will often vary a day in hatching.

Larva. The larvae on first hatching move with a looping gait, but soon take on the customary cutworm movement. This species grows faster, is more active, and feeds more greedily than most cutworms. The larvae are found by day hidden in loose soil, among surface trash, or under some object. They seem to the writer to be leaf feeders rather than typical cutworms in their feeding habits. Many records show that they climb plants to feed, and that in some cases they burrow for food, such as potato tubers. In case food is scarce the larvae will consume every green portion of the plant, and migrate some distance in search of food. In the insectary alfalfa, several common vegetables and weeds were greedily eaten, with special partiality for pigweed, cabbage, and turnip leaves. The larvae eventually reach a length of 1½ to 1¾ inches and a diameter of about ¼ inch. There is much variation in depth of color, but a row of yellow spots down the

mid-dorsal line is invariable, and easily distinguishes this species from others. As full growth is gained the larvae become quiet, shrink in size, and exhibit pupal motions when disturbed. The larva descends about 2 inches into the soil, constructs a roomy cell, and the pupa is formed therein.

In May and June, 1914, individual records of larval life varied from 24 to 28 days, averaging 26¼ days. In July, 1915, a large brood varied from 20 to 27 days in the larval stage, averaging 24 days. In September and October, 1915, the larval stage required from 5 to 6 weeks.

PUPA. The pupa is of the common Noctuid type, about an inch long. It is light brown when first formed, but darkens as development proceeds, until almost black. In June, 1914, individuals required from 13 to 16 days for the pupal stage; in June and August, 1915, the pupal stage was from 15 to 20 days, averaging 16 or 17; in October, 1915, nearly a month was required.

ADULT. The adult is a rather large moth, expanding about 1¾ inches. Two forms occur; one, the more numerous, is a sober brownish-gray in general color, the other a shade of purple, which does not retain its intensity in dry specimens. The pattern is the same in both, but the shade is quite distinct, and among several hundred moths only one has been seen that could be classed as intermediate.

The method of rearing had the disadvantage of giving few individual records of adult life. The longevity in 6 cages of moths varied from 8 to 13 days. Eggs are deposited within three days after emergence, and up to 2 or 3 days before death; in one cage eggs were deposited 12 days after the emergence of the youngest moth present. Females confined alone have in some cases deposited normal looking eggs, which failed to develop, as before noted. The eggs are usually deposited in masses, irregular, usually compact, although sometimes scattered. Eggs masses contained from 30 to 320 eggs, averaging 130. The moths preferred white cloth to any other available substance for oviposition. Judging from the number of egg masses found in a cage as compared with the number of moths present, a female may deposit more than one egg mass.

SUMMARY OF LIFE-CYCLE

TABLE OF LIFE-PERIODS IN SUMMER

| Stage | Minimum | Maximum | Average |
|---|---|---|---|
| Egg | 4 days | 6 days | 5.2 days |
| Larva | 20 " | 28 " | 24 " |
| Pupa | 13 " | 20 " | 16 " |
| Total | 37 " | 54 " | 45 " |
| Life-cycle[1] | 40 days | 57 days | 48 days |

[1]The life cycle in the last row is computed by adding 3 days as preoviposition period.

## Summary of Life Cycle

Observations on the time of maximum emergence and the time of maximum oviposition of two consecutive generations in 1915 confirm the conclusion that the average time required for a generation in summer is not far from 50 days in Southern Kansas.

Doctor Chittenden gives the larval stage for this species as 3 to 4 weeks at Washington, D. C., while Lintner states that it is 23 to 28 days in New York; both state that the pupal stage is from 11 to 20 days. Slingerland states that various workers have estimated the life cycle at 35 to 62 days; Doane and Brodie believed that in Washington State it was about 75 days.

## Seasonal History

At Wichita in 1915, 3 consecutive generations were reared. Larvae of these species, presumably of the first generation, were active late in May and in June, and pupated late in June; adults emerged early in July and deposited eggs soon after emergence. Second generation larvae hatching from these eggs pupated early in August, and became adults late that month. Eggs were deposited by these adults, and the larvae hatching from them developed more slowly during September. Many of them died, but some pupated in October and became adult in November, although subjected at times to freezing temperatures. In May, 1914, eggs of this species, evidently deposited by an overwintered individual, were found on a towel. They hatched May 14; the larvae pupated about June 10 to 15, and became adult late in June. From eggs deposited by them a few adults were reared in August. At Garden City in 1913 moth traps were run from early summer until late in November. A scattering occurrence of Lycophotia adults is noted all season, but they occurred in exceptional abundance at 3 periods; about July 10, August 15, and November 1. These periods of abundance must correspond to the first, second and third generations reared at Wichita in 1915. A few first generation larvae were reared at Wichita in 1916, and at Muscatine, Iowa, in 1919; in both cases the adults emerged late in June. Adults were seen flying in July at Wichita in 1917; In Iowa in 1919; and in Northern Illinois in 1920. In the latter locality a small larva, evidently of the second generation, was taken July 26, 1920.

From this it would seem that the species has three generations in

Kansas and neighboring states, though the third may be only partial; larvae hatching in May, July and late August respectively. Because of variations in development, extended oviposition and adult longevity, some adults are flying at almost any time in the season..

Only the first generation is usually injurious, larvae of the later generation being scarce and hardly noticeable in the field. This is probably due to parasitic attacks. In Kansas in 1915, and in Iowa in 1919, Lycophotia was heavily parasited by *Archytas analis*, a tachinid, and there are doubtless other important parasites. Records show that the later generations may be important in some cases; on the other hand, even the first generation larvae are scarce in many seasons,

Riley believed there were two and possibly three generations in Missouri; Fletcher, Lintner, Garman, Doane and Brodie, aud others have expressed the belief that two generations occur.

HIBERNATION: The writer has no direct evidence on the method of hibernation. Moths were abroad November 18, 1915 and December 4, 1917; and were reared under outdoor temperatures, emerging in November 1915. Moths were flying at Garden City in April, both in 1914 and 1915; and Mr. W. P. Flint states that they have been observed in March in Illinois. Noctuid larvae and pupae have been carefully collected by the writer during winter and early spring in several seasons, but none of Lycophotia have been found among these collections. The facts that adults are present so late in the fall and early in the spring, and that larvae or pupae of this species have not been found during the winter, suggests that the species hibernate as adult.

Gillette records adults flying in late fall: on the other hand, both Chittenden and Forbes record finding larvae at different times in winter, and Doane and Brodie wintered the species as pupae in the insectary. It may be that more than one stage hibernates, as Doctor Chittenden suggests. From the facts the writer has, it seems likely that the adult is the principal, if not the only hibernating stage in southern Kansas, More work should be done on this phase of the seasonal history.

## DIMORPHISM

As noted before, two forms of adults occur. On confining these types of moths in separate cages, it was found that the purple form did not reproduce. In only one case were eggs found in the cage of purple moths, and these eggs were abnormal, appeared withered, and failed to develop. The gray moths deposited eggs in great abundance,

whether purple moths were present with them or not, and these eggs always developed normally when both sexes were present. When gray females were confined alone they deposited infertile eggs in some cases. Some gray females deposited eggs which gave rise to both gray and purple moths, in one large brood in about equal numbers; others had only gray progeny.

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Adjournment.

## LIFE HISTORY OF *PYRAUSTA AINSLIEI* HEINR. AT AMES, IOWA, DURING THE SEASON OF 1920

By. I. L. Ressler, *Iowa State College, Ames, Iowa*

Since the introduction of the European Corn-borer into the United States there has been much discussion as to the consequence should this pest appear in the corn belt. This led to the study of the life history of *Pyrausta ainsliei* Heinr., a native borer (smartweed stem-borer), as one of the projects of the Iowa Agricultural Experiment Station at Ames. The larvae and adult females of *P. ainsliei* so closely resemble the larvae and adult females of *P. nubilalis* Hubner (the European Corn-Borer) that the two are easily confused.[1]

### Injury

The writer has not observed the work of the insect in corn, since it

will only feed in corn when there is a scarcity of its natural food plant, *Polygonum hydropiper* L. (smartweed). The larvae burrow into the Polygonum stem and eat their way upward until ready to pupate. The point of entry is a circular opening. The writer has noticed that infested stems prematurely turned red just as older uninfested plants do. It has been said that this turning red has been caused entirely by *P. ainsliei*. This is apparently not the case, but merely seems as if the process is hastened by the infestation. As many as seven larvae have been taken from a single stem in infested fields, although the number usually only ranged from one to three. The nature of the injury to corn, which is decidedly unlike that of the European Corn-Borer, has been fully described by W. E. Britton in his Nineteenth Report.[2]

## Distribution And Food Plants

*P. ainsliei* occurs throughout the Eastern and Middle Western States having been found in Massachusetts, Connecticut, New York, New Jersey, Tennesee, Illinois, Missouri, Kansas and Iowa.[1] W. P. Flint and J. R. Malloch have published a list of twenty food plants of this species, mentioning the fact, however, that specimens have not been found in any of them except where they were growing near infested Polygonum.[3]

## Life History At Ames

Two broods of the insect occur during the season at Ames, Iowa. The larvae winter over in their burrows in smartweed after closing the opening with excrement. In the spring they became active for a short time and entered the pupal stage during late May and early June, the moths emerging after a pupal period of from ten to fourteen days during the latter part of May and the first half of June.

After a short flight the moths deposited their eggs on the underside of smartweed leaves in masses containing from eleven to fifty eggs. The writer has not been able to determine the total number of eggs laid by a single female, nor has he been able to induce reared females to deposit eggs in the insectary, but observations upon dissections of females indicate that a single individual deposits several hundred. The eggs are glistening white, flat, nearly circular in shape and overlap each other on the leaf at deposition. Daily field trips were made and the first egg masses were observed on June tenth, after which they could be found freshly laid until July tenth. The incubation

period lasted from six to ten days. Considerable difficulty was experienced in hatching eggs out in the insectary at the start due to rapid changes in temperature and moisture conditions. This was soon remedied, however, and the results obtained in the insectary tallied with the observations in the field. Just before hatching the egg turned a brownish color.

The larvae of the summer generation hatched in the latter part of June and continued through a period until about July tenth. The newly hatched larvae began to feed almost immediately in the midrib of the leaf but soon migrated to the stem where they made a circular opening, entering the stem almost invariably just above a node.

The pupae of this generation were observed about the end of July and the last on August twenty-third. Just before pupating, the larvae spun a delicate, white silken curtain across its burrow just in front and back of itself, forming a cell. The pupal stage extended over a period of from nine to fourteen days, the average length being twelve days. The first moths emerged August tenth and were observed in flight until September fourth. These moths began to deposit eggs

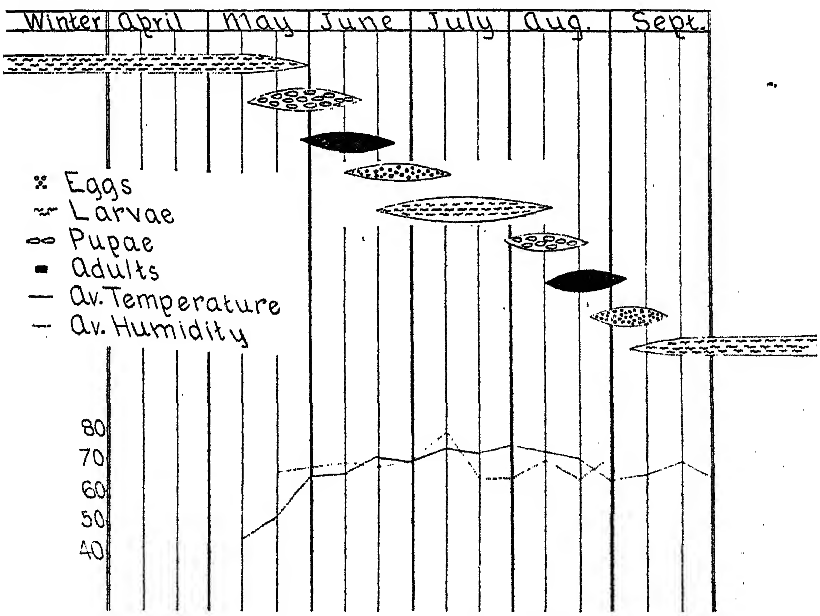


Fig. 6 Diagram of Life History of *P. ainsliei* Showing also Average Temperature and Average Humidity for the Season of 1920 at Ames, Iowa.

in the latter part of August and first half of September. The first overwintering larvae hatched out above the eighth of September and were in evidence until nearly the end of the month. The larvae fed actively until cool weather when they plugged their entry holes in preparation for hibernation.

The chart above (Fig. 6) diagrams the life history as correlated with the average temperature and humidity records of the station for the season of 1920.

## Natural Enemies

One very important hymenopterous parasite of *P. ainsliei* of the family *Braconidae*, genus *Aleiodes*, was reared. While boring insects do not usually have natural enemies of sufficient importance to be considered as a factor in the control of the insect, this parasite will undoubtedly reduce the percentage of infestation during the coming season. Fully fifty per cent of the larvae collected were parasitized, each one having from four to eight Braconid larvae on it.

## Conclusion

The European Corn-Borer has two complete generations in Massachusetts, which closely parallels the life history of *P. ainsliei* as worked out at Ames. While each of the stages appeared a little later during 1920 at Ames than like stages appeared in the European Corn-Borer in Massachusetts, this can no doubt be explained by the fact that each was studied during different years, under varying degrees of temperature conditions. Given similar conditions for each, it is the writer's opinion that the two insects would parallel each other in Iowa, should *P. nubilalis* be introduced into the state. The problem before us is a grave one, far reaching in its consequences, and no efforts should be lost in the work to prevent the further spread of this pest.

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# THE EFFECT OF POISON BRAN MASH ON GRASSHOPPERS AND THE LAPSE OF TIME BETWEEN POISONING AND DEATH[1]

By A. L. FORD, *Scientific Assistant, Bureau of Entomology, West Lafayette, Indiana*

The feeding powers of normal, healthy grasshoppers are well known by practically every farmer. Also those who have used poison bran mash for their control know that it is not an instantaneous killer, in fact it usually takes one or two days for a hopper to die after feeding on the poison. These two facts often tend to discourage the use of poison mash for grasshopper control. Since a large army of hoppers is capable of consuming vast amounts of green food in a single day, many farmers say "Why poison when it will not kill for two days as my crop will be taken in that length of time anyway."

The writer has had to contend with this idea many times and yet he had no positive data showing that the farmer was wrong. It was with this in view that the author started to compile data showing that although poisoned hoppers appear perfectly healthy until a short time before death, they consume very little food after poisoning as compared with unpoisoned hoppers during the same period of time.

The work was done at the field laboratory of the Bureau of Entomology at Lafayette, Indiana during the late summer and early fall of 1919. A serious infestation of *Melanoplus femur-rubrum* occurred in this locality at that time thus facilitating the work greatly. All experiments were performed on adults of *Melanoplus femur-rubrum*.

Adults of the above species were collected from the field by hand sweeping and placed in screen cages without food, where they were left for one day in order to become sufficiently hungry to feed in captivity. A small amount of poison bran mash was then mixed and placed in the cage. As the hoppers therein came to feed on it they were timed in minutes. After feeding for the required time (two minutes) each hopper was removed and placed in an individual lantern globe cage together with a piece of green corn leaf cut to known dimensions. This food was changed frequently until the hopper's death. Each time the corn leaf was removed the area eaten was traced on cards, each hopper having an individual card. Later the total area eaten by each hopper was determined in square inches of corn leaf by means of the planimeter. In this way the amount each hopper ate between the time of poisoning and death was accurately calculated. Unpoisoned hoppers freshly swept from infested fields were run as

checks along with the poisoned one in each experiment, thus giving the difference in the amount of food eaten by poisoned and unpoisoned hoppers for the same period of time.

In this work poison mash mixed with Paris green, white arsenic and crude arsenic were used and data obtained on the effect of these different arsenicals on the feeding capacity of grasshoppers. Also data were obtained on the length of time required for these various poisons to kill, together with the effect of different amounts of poison mash consumed on the time of death and food eaten after poisoning.

The following table shows the difference in the amount of corn leaf eaten during the same length of time by unpoisoned hoppers and those poisoned by mash containing Paris green.

TABLE I

| Expt. No. | No. hoppers poisoned | No. check hoppers | Aver. time between poisoning and death | Aver. time check hoppers were allowed to feed | Aver. amt. corn leaf eaten by poisoned hoppers | Aver. amt. corn leaf eaten by check hoppers |
|---|---|---|---|---|---|---|
| 1996 | 1 | 1 | 48 hrs. | 48 hrs. | 0.07 sq. in. | 0.96 sq. in |
| 1997 | 9 | 3 | 38 " | 38 " | 0.08 " " | 1.99 " " |
| 19152 | 9 | 9 | 44.9 " | 44.9 " | 0.12 " " | 0.61 " " |
| 19155 | 10 | 10 | 23.8 " | 23.8 " | 0.014 " " | 0.93 " " |
| | Averages | | 35.5 hrs. | | 0.071 " " | 0.944 " " |

The poison mash used in the experiments, the results of which were shown in Table I, was mixed according to the following formula: ½ lb. Paris green; 25 lbs. wheat bran, and 2 qts. black strap molasses, no fruit being used. In the four experiments, individual records were kept on 29 poisoned hoppers and 23 check (unpoisoned) hoppers, both groups being allowed to feed for the same length of time. The average period between poisoning and death for the lot was 35.5 hours. During this time the poisoned hoppers ate an average of 0.071 square inches of corn leaf each, while the unpoisoned hoppers ate an average of 0.944 square inches, showing that the unpoisoned consumed slightly over 13 times as much food as the poisoned ones.

The following table shows the difference in the amount of corn leaf eaten by unpoisoned hoppers and those poisoned by mash containing white arsenic, during the same period of time.

TABLE II

| Expt. No. | No. hoppers poisoned | No. check hoppers | Aver. time between poisoning and death | Aver. time check hoppers were allowed to feed | Aver. amt. eaten by poisoned hoppers | Aver. amt. eaten by poisoned hoppers |
|---|---|---|---|---|---|---|
| 1998 | 9 | 9 | 55 hrs. | 55 hrs. | 0.295 sq. in. | 0.816 sq. in. |
| 19156 | 10 | 10 | 33.9 " | 33.9 " | 0.022 " " | 1.26 " " |
| | Averages | | 43.9 " | | 0.151 " " | 1.049 " " |

The poisoned mash used in experiments, the results of which are shown in Table II, was mixed according to the following formula: White arsenic ¾ lbs.; wheat bran 25 lbs. and black strap molasses 2 quarts, no fruit being used. In these two experiments individual records were kept on 19 poisoned hoppers and 19 check (unpoisoned) hoppers, both groups being allowed to feed for the same period of time. The 19 poisoned hoppers ate an average of 0.151 square inches of corn leaf each between the time of poisoning and death, while the unpoisoned hoppers ate an average of 1.049 square inches during the same period of time, showing that the unpoisoned consumed approximately seven times as much food as the poisoned ons.

The following table shows the difference in the amount of corn leaf eaten by unpoisoned hoppers and those poisoned with bran mash containing crude arsenic, during the same period of time.

TABLE III

| Expt. No. | No. hoppers poisoned | No. check hoppers | Aver. time between poisoning and death | Aver. time check hoppers were allowed to feed | Aver. amt. corn leaf eaten by poisoned hoppers | Aver. amt. eaten by check hoppers |
|---|---|---|---|---|---|---|
| 1996 | 1 | 1 | 48 hrs. | 48 hrs. | 0.11 sq. in. | 0.96 sq. in. |
| 19100 | 11 | 11 | 70.7 " | 70.7 " | 0.31 " " | 1.867 " " |
| 19158 | 10 | 10 | 27.5 " | 27.5 " | 0.024 " " | 1.202 " " |
| | | Averages | 50 hrs. | | 0.166" " | 1.525 " " |

The poison mash used in the experiments, the results of which are shown in Table III, was mixed according to the following formula: 1½ lbs. crude arsenic, 25 lbs. wheat bran, and 2 quarts black strap molasses, no fruit being used. In these experiments individual records on 22 poisoned hoppers were kept, together with 22 check (unpoisoned) hoppers. The unpoisoned ones ate an average of 1.525 square inches of corn leaf each, while those which were poisoned ate only an average of 0.166 square inches, showing that the unpoisoned hoppers consumed approximately nine times as much food as the poisoned ones during the same period of time.

Averaging the three sets of experiments tabulated above, it is seen that complete and individual records were kept on 80 poisoned and 74 unpoisoned hoppers. The poisoned ones ate an average of 0.122 square inches of corn leaf between the time of poisoning and death, while those that were not poisoned ate an average of 1.175 square inches during the same length of time. Thus the unpoisoned hoppers ate 9.6 times as much food as those which were poisoned.

Taking up the question of the length of time required to kill by the three poisons, we find from the data set forth in the three tables above, the following interesting facts. The 29 hoppers poisoned by bran

mash containing Paris green lived for an average of 35.5 hours after being poisoned, the 19 individuals receiving the white arsenic mash lived for an average of 43.9 hours after poisoning, and those poisoned by crude arsenic mash continued to live for an average of 50 hours after poisoning. The poison mash mixed with Paris green killed quicker than the others, that mixed with crude arsenic being an average of 14.5 hours slower. The average length of time taken for the white arsenic to kill was about midway between the Paris green and crude arsenic.

The amount of poison bran mash required to kill grasshoppers and the effect of different amounts consumed on the rapidity of kill and amount of food eaten after poisoning was next considered. These experiments were performed by allowing the hoppers to feed on poisoned mash (½ lb. Paris green and 2 quarts black strap molasses for each 25 lbs. of wheat bran) for different lengths of time, thus consuming different amounts. These were then placed in individual cages and treated similar to the hoppers in the experiments previously shown.

The following table shows the length of time between poisoning and death and the amount of food eaten after poisoning by hoppers receiving different amounts of poison bran mash.

TABLE IV

| No. hoppers used | Time allowed to feed on poison bran mash | Average time between poisoning and death | Average amount of corn leaf eaten between poisoning and death |
|---|---|---|---|
| [1]5 | 30 seconds | 10.5 hrs. | 0.037 sq. in. |
| 5 | 1 minute | 28.6 hrs. | 0.067 " " |
| 5 | 2 minutes | 23.7 hrs. | 0.038 " " |
| 5 | 3 minutes | 38.6 hrs. | 0.294 " " |
| 5 | 4 minutes | 20.8 hrs. | 0.078 " " |

These data apparently show that the hoppers receiving the smallest amount of poison bran mash died quicker and ate less after being poisoned than any of the other groups. However, one of the hoppers in this group failed to become poisoned at all, and must be taken into consideration. Those hoppers which fed on the poison for 3 minutes lived longer and ate more than any of the other groups.

Summarizing the data set forth in this paper, it can be said that although grasshoppers may appear healthly and active for many hours after eating poison bran mash, they consume very little food as compared with unpoisoned hoppers, the data showing less than one ninth as much. Because of this no farmer who has poisoned should be discouraged if the hoppers remain active in fields for a considerable period

[1]One hopper from the 30 seconds group failed to become poisoned.

of time after treatment with poison bran mash. Furthermore the last experiment seems to indicate that it takes very little poisoned bran mash to kill a hopper and those receiving smaller amounts die just as soon and eat just as little after poisoning as those consuming larger amounts.

## OBSERVATIONS ON THE ATTRACTIVENESS OF MATERIALS USED IN GRASSHOPPER BAITS[1]

By A. L. Ford, and W. H. Larrimer *Scientific Assistants, Bureau of Entomology West LaFayette, Indiana*

During recent years conflicting results as regards efficiency of kill seem to have been obtained from the use of various substances in grasshopper baits. Favorable results have been reported from such widely differing mixtures as those made without fruit flavors or syrups, those in which sawdust has been substituted for wheat bran, and those containing vinegar and salt as attracting agents. Many substances have been suggested as attractive baits without even giving them a trial. This confusion clearly shows that much work remains to be done along this line, especially in those regions east of the Mississippi river where, for some unknown reason, grasshoppers have been on the increase for several years.

During the summer of 1919 a serious outbreak of *Melanoplus femur-rubrum* occurred at Lafayette, Indiana, thus furnishing an excellent oportunity for either increasing or clearing up some of this confusion. Accordingly, a series of experiments was planned with reference to the attractiveness of materials used in grasshopper baits, always keeping their availability and cheapness in mind.

By this plan the following points were to be determined.

1st. The comparative attracting power of various flavors.

2nd The relative attracting values of various syrups.

3rd. The attracting values of various body materials in poison bran mash.

To obtain accurate data on these points, the most promising of the various flavors, syrups and materials were selected from those which have been reported. It was necessary to place equal amounts of the mash, mixed in various ways, in the infested fields and record the number of hoppers attracted to them under natural field conditions.

The next problem was to make an accurate count of the hoppers attracted to these baits. In order to secure the count by ordinary ob-

servation it was necessary to approach so close to the bait that part of the hoppers were frightened away. Several types of traps were constructed, any of which would successfully retain the hoppers, once they had entered, thus making possible an accurate count. All of these were unsuccessful since the hoppers apparently preferred to observe the bait from the outside rather than enter the trap and feed.

Next, a few experiments were tried with a pair of army field glasses (Prism stereo 6 power) with which it was possible to make accurate counts with the observer stationed from twenty to thirty feet from the bait.. The grasshoppers seemed to have no objection to this method of procedure and it proved so satisfactory that all the data recorded in this paper were secured by the aid of these glasses.

All bait combinations were mixed in small batches, care being taken to add the various ingredients in their exact proportions. Equal amounts of the various baits were placed, each in the center of a heavy card-board disc, one foot in diameter and checked off in squares by heavy black lines to make the counts both easier and more accurate.

All hoppers observed feeding or within the six inch radius of the bait were included in each count, these counts being made at short intervals throughout the day. In order to eliminate any possible error due to greater abundance of grasshoppers in some locations, in all experiments the position of the cards was interchanged after every few counts. Thus the number of hoppers attracted to the various combinations of materials used in the baits was accurately determined. Most of the experiments were performed on a tract of uncultivated land covered with a rank growth of weeds and heavily infested with grasshoppers, *M. femur-rubrum* being by far the predominating species.

In the following experiments 16 flavors were used in 26 different combinations. The tables show the flavors which were run side by side on the same day, the number of counts made on each, and the total number of hoppers counted at each bait during the day. In these tables the word molasses is given for the common black strap molasses. The proportions in which the various flavors were used are as follows:– Black strap molasses, 2 quarts to 25 lbs. of bran. Fusel oil, anise oil and lemon extract, from 1 to 2 ounces to 25 lbs. of bran. Cider, vinegar, and grape juice, 1 quart to 25 lbs. of bran. Watermelon, cantelope, tomatoes and apple pomace, enough to make 1 quart to each 25 lbs. of bran.

TABLE I - EXPERIMENT 1938 RUN ON AUGUST 2, 1919 IN LIGHTLY INFESTED RAPE FIELD.

| Flavor | Total No. counts during the day. | Total No. hoppers attracted during day. |
|---|---|---|
| Check (Wet bran) | 50 | 7 |
| Fusel oil & molasses | 50 | 21 |
| Apple & molasses | 50 | 16 |
| Anise oil & molasses | 50 | 10 |
| Lemon ext. & molasses | 50 | 12 |
| Totals | 250 | 66 |

TABLE II - EXPERIMENT 1939 RUN ON AUGUST 4, 1919 AT EDGE OF WHEAT STUBBLE FIELD.

| Flavor | Total No. counts during the day. | Total No. hoppers attracted during day. |
|---|---|---|
| Apple & molasses | 33 | 97 |
| Lemon ext. & molasses | 33 | 107 |
| Molasses & salt | 33 | 47 |
| Lemon peel & molasses | 33 | 107 |
| Molasses alone | 33 | 131 |
| Anise oil & molasses | 33 | 79 |
| Apple, salt & molasses | 33 | 62 |
| Orange peel & molasses | 33 | 132 |
| Check (wet bran) | 33 | 178 |
| Fusel oil & molasses | 33 | 132 |
| Watermelon & molasses | 33 | 128 |
| Totals | 363 | 1200 |

TABLE III - EXPERIMENT 1940 RUN ON AUG. 5, 1919, ON INFESTED LAND GROWN TO WEEDS.

| Flavor | Total No. counts during the day. | Total No. hoppers attracted during day. |
|---|---|---|
| Check (Wet bran) | 13 | 66 |
| Molasses alone | 13 | 228 |
| Watermelon alone | 13 | 201 |
| Watermelon & molasses | 13 | 114 |
| Apple alone | 13 | 199 |
| Apple & molasses | 13 | 252 |
| Anise oil alone | 13 | 68 |
| Anise oil & molasses | 13 | 46 |
| Orange peel alone | 13 | 33 |
| Orange peel & molasses | 13 | 57 |
| Lemon peel alone | 13 | 82 |
| Lemon peel & molasses | 13 | 114 |
| Fusel oil alone | 13 | 41 |
| Fusel oil & molasses | 13 | 34 |
| Totals | 182 | 1535 |

TABLE IV - EXPERIMENT 1941 RUN ON AUG. 5, 1919, ON INFESTED LAND GROWN TO WEEDS

| Flavor | Total No. counts during the day. | Total No. hoppers attracted during day. |
|---|---|---|
| Check (Wet bran) | 13 | 345 |
| Molasses alone | 13 | 724 |
| Watermelon alone | 13 | 610 |
| Watermelon & molasses | 13 | 598 |
| Apple alone | 13 | 658 |
| Apple & molasses | 13 | 720 |
| Anise oil alone | 13 | 220 |
| Anise oil & molasses | 13 | 185 |
| Orange peel alone | 13 | 206 |
| Orange peel & molasses | 13 | 406 |
| Lemon peel alone | 13 | 371 |
| Lemon peel & molasses | 13 | 432 |
| Fusel oil alone | 13 | 320 |
| Fusel oil & molasses | 13 | 243 |
| Totals | 182 | 6038 |

TABLE V - EXPERIMENT 1942 PERFORMED ON AUGUST 13, 1919, ON INFESTED LAND GROWN TO WEEDS.

| Flavor | Total No. counts during the day | Total No. hoppers attracted during day |
|---|---|---|
| Fusel oil & molasses | 55 | 858 |
| Orange pulp alone | 55 | 883 |
| Anise oil & molasses | 55 | 804 |
| Watermelon alone | 55 | 690 |
| Molasses alone | 55 | 1113 |
| Apple alone | 55 | 950 |
| Apple & molasses | 55 | 991 |
| Watermelon & molasses | 55 | 858 |
| Anise oil & molasses | 55 | 967 |
| Lemon pulp & molasses | 55 | 1052 |
| Check (wet bran) | 55 | 1041 |
| Orange pulp & molasses | 55 | 1054 |
| Lemon pulp alone | 55 | 1023 |
| Fusel oil alone | 55 | 947 |
| Totals | 770 | 13231 |

TABLE VI - EXPERIMENT 1960 PERFORMED ON AUGUST 13, 1919, ON INFESTED LAND GROWN TO WEEDS

| Flavor | Total No. counts during the day | Total No. hoppers attracted during day |
|---|---|---|
| Cider & molasses | 50 | 328 |
| Tomatoes & molasses | 50 | 225 |
| Lemon pulp & molasses | 50 | 294 |
| Anise oil & molasses | 50 | 262 |
| Check (wet bran) | 50 | 304 |
| Vinegar & molasses | 50 | 417 |
| Cantelope & molasses | 50 | 400 |
| Lemon peel & molasses | 50 | 343 |
| Fusel oil & molasses | | 282 |
| Apple pomice & molasses | 50 | 260 |
| Apple & molasses | 50 | 340 |
| Lemon ext. & molasses | 80 | 238 |
| Grape juice & molasses | 50 | 225 |
| Orange peel & molasses | 50 | 216 |
| Molasses alone | 50 | 292 |
| Totals | 750 | 4426 |

In the experiments shown in the preceding tables, a total of 26,496 hoppers were recorded in 2497 separate counts. With data on this large number of individuals, certainly fairly accurate conclusions can be drawn. The totals for these six experiments show that of these 26 flavor combinations used, black strap molasses without additional flavor attracted more hoppers than any other, apple and black strap molasses being second, and the check (wet bran) third.

The advantage of using the well known citrus fruit flavors is not borne out here as in every case those combinations containing citrus fruits were well down the list when taken in the order of the total number of hoppers attracted in the six experiments, even the check (wet bran alone) giving a much better total than any of these. Since the check ran so high in the list, one might well think that there is nothing gained by the use of any kind of flavors or syrups in poison

bran mash for grasshoppers. The data show that the check total was 1941 hoppers while the black strap molasses totaled 2488, being 547 or slightly over 28% more than the check. Certainly one could well afford to add black strap molasses at the rate of 2 quarts per each 25 pounds of bran to obtain a 28% increase in attractiveness

In experiment 1960 (Table VI) it is seen that vinegar and black strap molasses lead the list with 417 hoppers, cantelope and black strap being second with 400. Due to lack of time these two combinations were run but once and showed up favorably. As soon as opportunity affords further experimentation will be performed on these flavors.

Next it was decided to determine whether or not the use of salt in bran mash adds to its power to attract grasshoppers. Accordingly an experiment was devised whereby four flavor combinations with and without salt (enough to taste strongly) were run side by side as were the experiments shown above. The following table shows the flavors used, the total number of counts made, and the total number of grasshoppers attracted to each.

Table VII - Experiment 1942, Performed on August 7, 1919 of Infested Land Grown To Weeds.

| Flavor | Total number of counts | Total number hoppers attracted Without salt, | With salt |
|---|---|---|---|
| Lemon ext. & molasses | 25 | 343 | |
| Lemon ect., molasses & salt. | 25 | | 213 |
| Lemon peel, & molasses | 25 | 436 | |
| Lemon peel, molasses & salt | 25 | | 276 |
| Apple & molasses | 25 | 297 | |
| Apple, molasses & salt | 25 | | 261 |
| Molass alone | 25 | 343 | |
| Molasses & salt | 25 | | 339 |
| Totals | 200 | 1419 | 1089 |

The above table shows that a total of 3508 hoppers were recorded in 200 separate counts. In every case the combinations without salt attracted a greater number of hoppers, the total being over 23% more. This would indicate that no benefits are derived from the use of salt in bran mash for grasshoppers, in fact here it apparently repels rather than attracts them.

## Syrup Experiments

Having come to a definite conclusion concerning the attractiveness of flavors in bran mash, next it was decided to make observations on the attractive powers of various syrups. Several of the more common syrups were secured and used in the mixing of small amounts of bait

at the rate of 2 quarts to each 25 pounds of wheat bran. The mixtures were placed on cards in an infested field and run similar to the experiments explained above. The following table shows the syrups used, the total number of counts made, and the total number of hoppers attracted to each.

TABLE VIII - EXPERIMENT 1968 PERFORMED ON AUGUST 26, 1919 ON INFESTED LAND GROWN TO WEEDS.

| Syrup | Total counts made. | Total number hoppers attracted. |
|---|---|---|
| Black Strap Molasses | 60 | 831 |
| Dark Karo Corn Syrup | 60 | 490 |
| Light Karo Corn Syrup | 60 | 510 |
| Sorghum | 60 | 476 |
| New Orleans Molasses | 60 | 439 |
| Check (wet bran) | 60 | 435 |
| Totals | 360 | 3181 |

The syrups were run in duplicate, 30 counts being made from each, the combined results of which are shown in the above table. These data show that black strap molasses attracted by far more hoppers than any of the other syrups, which were very little better than the check (wet bran).

## EXPERIMENTS ON BODY MATERIALS

The recent advance in the price of wheat bran has made its use in grasshopper baits almost prohibitive in certain localities. Not only this but it has been impossible to secure wheat bran at any price in certain regions. Accordingly an experiment was planned whereby various body materials were run side by side, as shown in the above experiments and records made of the number of hoppers attracted to each. In all of these combinations black strap molasses was used at the rate of 2 quarts to each 25 pounds of body material.

TABLE IX - EXPERIMENT 1946, PERFORMED ON AUGUST 11, 1919 ON INFESTED LAND GROWN TO WEEDS.

| Body Material | Total number counts | Total number hoppers attracted. |
|---|---|---|
| Hickory sawdust | 48 | 1571 |
| Hickory sawdust & bran 50-50 | 48 | 2891 |
| Red gum sawdust | 48 | 1975 |
| Red gum sawdust & bran 50-50 | 48 | 2207 |
| Hardwood sawdust | 48 | 1430 |
| Hardwood sawdust & bran 50-50 | 48 | 2201 |
| Soft pine sawdust | 48 | 1303 |
| Soft pine sawdust & bran 50-50 | 48 | 2046 |
| Horse manure | 48 | 1214 |
| Bran alone | 48 | 2522 |
| Totals | 480 | 19,040 |

This table shows that in every case sawdust and wheat bran mixed in equal parts attracted more grasshoppers than did the sawdust alone. The hoppers attracted to the four mixtures containing only sawdust totaled 6459 while those counted from the four containing 50% bran, totaled 8845, which shows an increase in attractiveness of 36.9% due to the use of 50% bran. The mixture containing bran alone headed the list with 2522 hoppers but this was only 311 or 14% more than the average of the four mixtures containing bran and sawdust in equal portions. The bait made from horse manure fell far below any of the rest, showing that its attractive power for grasshoppers is comparatively low.

Table X shows the conditions of temperature and humidity for the days on which the preceding experiments were run.

TABLE X - TEMPERATURE AND HUMIDITY RECORDS. LAFAYETTE, INDIANA.

| Date 1919 | 6 A.M. T. H. | 8 A.M. T. H. | 10 A.M. T. H. | 12M. T. H. | 2 P.M. T. H. | 4 P.M. T. H. | 6 P.M. T. H. | Min. T. H. | Max. T. H. | Mean T. H. |
|---|---|---|---|---|---|---|---|---|---|---|
| Aug. 2 | 56 89 | 60 87 | 70 50 | 76 42 | 77 42 | 78 40 | 78 42 | 56 40 | 78 90 | 71 56 |
| Aug. 4 | 71 71 | 73 79 | 76 75 | 90 60 | 94 47 | 97 40 | 95 42 | 71 40 | 97 79 | 85 59 |
| Aug. 5 | 75 88 | 78 84 | 80 78 | 74 95 | 79 83 | 78 80 | 81 68 | 81 68 | 75 95 | 77 82 |
| Aug: 7 | 69 94 | 72 84 | 75 70 | 81 65 | 87 50 | 88 46 | 87 44 | 69 44 | 88 94 | 80 65 |
| Aug. 11 | 55 89 | 55 89 | 66 60 | 79 44 | 82 39 | 82 36 | 78 39 | 82 36 | 55 89 | 71 56 |
| Aug. 13 | 68 66 | 65 94 | 67 98 | 75 77 | 78 64 | 82 62 | 80 75 | 65 62 | 82 98 | 73 76 |
| Aug. 26 | 50 99 | 51 100 | 68 52 | 75 41 | 76 41 | 76 40 | 76 40 | 50 40 | 76 100 | 66 59 |

T = Temperature
H = Humidity

## CONCLUSION

The data herein reported indicate the following:-

1. Fruit flavors in bran mash when used against *M. femur-rubrum* under Indiana conditions, at least, apparently are not necessary.
2. Black strap molasses was found to be the best of the flavor combinations used.
3. Salt does not add to the attractiveness of poison bran mash.
4. Black strap molasses was better than any of the syrups herein tested, all others being only slightly better than wet bran alone.
5. Sawdust and bran used in equal parts as a body material for mash attracted 36.9% more hoppers than sawdust alone.
6. Sawdust and bran used in equal parts as a body material for bran mash attracts nearly as many hoppers as wheat bran alone.

# SOME FACTORS INFLUENCING THE EFFICIENCY OF GRASS-HOPPER BAITS[1]

By A. L. FORD and W. H. LARRIMER, *Scientific Assistants, Bureau of Entomology, West LaFayette, Indiana*

Important considerations in grasshopper control have always been, the best poison to use, the proper strength at which to include it in the bait, and the rate of application of the mixture over the infested area in order to obtain a maximum kill. In order to obtain information on these points a series of experiments were conducted during the summer of 1919 at Lafayette, Indiana in fields infested with grasshoppers, of which at least 99% were *Melanoplus femur-rubrum*. Preliminary to this work the maximum daily feeding period was found to be from 8:30 A.M. until 12:30 P.M. (Daylight saving time). It was also necessary to determine which syrup would prove most attractive to grasshoppers. The experiments as here reported can be grouped according to the following outline:-

1st. To determine the comparative efficiency of various syrups when used under field conditions.

2nd. To determine the optimum strengths of various arsenicals in bran mash.

3rd. To determine the optimum rate of application per acre for poison bran mash.

4th. Having found the optimum strengths and rates of application for the various arsenicals, to determine which of them is most efficient when used under its optimum conditions.

## METHOD OF OBTAINING PERCENTAGE OF KILL

In estimating the percentage of grasshoppers killed by poison bran mash, practically all workers on this subject have merely counted the number of dead hoppers per unit area of ground and estimated the number of living hoppers remaining. The writers believe that this is not an accurate method for two reasons. 1st. It is impossible to even estimate accurately the number of living grasshoppers per unit area because of the unusual activeness of this group of insects. 2nd. To count the number of poisoned hoppers per unit area is inaccurate since not only many hoppers enter cracks in the soil or seek low shady places to die, but other insects and birds consume or carry away many of them before a count can be made.

[1]Published by permission of the Secretary of Agriculture.

The following method was devised with the idea of making the observations more accurate. Quarter acre plots in an infested alfalfa field were treated with the poison mash, care being taken to keep each plot well isolated from the others to avoid error due to the hoppers migrating from one plot to another. After allowing the hoppers to feed on the poison mash in the field for several hours, but not long enough for any of them to succumb to its effects, sweepings were made with hand nets from the poisoned plots. In all of the following experiments the poison bran mash was applied to the infested plots between 8 A.M. and 9 A.M. and the sweepings made between 2 and 3 P.M. of the same date. The hoppers thus swept were placed in bags and brought to the laboratory where they were put in out of door screen cages with green corn suckers for food. In each case a lot of hoppers were swept from an unpoisoned area and run as a check. The cages were examined daily and the dead hoppers removed and recorded. At the end of six days the experiment was closed and the number of living hoppers remaining in each cage recorded. Thus the number of hoppers killed by each application of poison mash and the number of hoppers surviving was accurately determined.

## Syrup Experiments

A series of experiments was planned whereby the percentage of kill due to the various syrups was determined. Small amounts of poison mash were mixed with Paris green at the rate of one pound per each 25 lbs. of bran and the various syrups as shown in the following table. Quarter acre plots were treated with these various mixtures as described above, and the hoppers handled as previously explained. This experiment was run in duplicate, the following table showing the combined results of these two series.

Table I (Poison mash applied Aug. 28).

| Syrup | Total No. hoppers swept | No. dead hoppers removed | No. living hoppers remaining | Percentage of kill. |
|---|---|---|---|---|
| Black strap 2 qts. per 25 lbs. bran | 107 | 97 | 10 | 90.6 |
| Black strap 1 qt. per 25 lbs. | 213 | 192 | 21 | 90.1 |
| Dark Karo 2 qts. per 25 lbs. | 188 | 126 | 62 | 67.0 |
| Dark Karo 1 qt. per 25 lbs. | 196 | 129 | 67 | 65.8 |
| Light Karo 2 qts. per 25 lbs. | 196 | 145 | 51 | 73.9 |
| Light Karo 1 qt. per 25 lbs. | 227 | 168 | 59 | 74.0 |
| Sorghum 2 qts. per 25 lbs. | 131 | 85 | 46 | 65.1 |
| Sorghum 1 qt. per 25 lbs. | 175 | 106 | 69 | 60.5 |
| Orleans molasses 2 qts. per 25 lbs. | 220 | 156 | 64 | 70.9 |
| Orleans molasses 1 qt. per 25 lbs. | 220 | 183 | 37 | 83.1 |
| Wet bran alone | 284 | 234 | 50 | 82.4 |
| Check (Unpoisoned) | 178 | 11 | 167 | 6.1 |
| Totals | 2335 | 1632 | 703 | |

The mixtures containing black strap molasses were noticeably better than the rest, both of these giving better than 90% kill, there being little difference between the two quart and one quart strengths. All of the other syrups except Orleans molasses at the one quart strength were even poorer than the mixture without any syrup. The check (unpoisoned) showed a mortality of 6.1% during the six days of confinement.

## Optimum Strength of Arsenicals

Having determined (to the writers' satisfaction) the best time to apply poison bran mash in the field and the proper syrup to obtain the maximum results, experimental work was started on the various arsenicals used in bran mash. In all of the following experiments black strap molasses was used without fruit flavors, these having been found unnecessary by another series of experiments.

First it was decided to determine, if possible, the most efficient strength of arsenicals in poison bran mash, basing this both on percentage of kill and cost to the farmer. A series of experiments was arranged whereby the common arsenicals namely, Paris green, white arsenic ($As_2O_3$) and crude arsenic (crude arsenious oxide) were used at varying strengths, as shown in the following tables. The mash was applied and the resulting percentages of kill obtained by the method previously explained. Each series of experiments was performed in duplicate, the following tables giving the combined results. These tables show the poison used, its strength, the total number of hoppers swept, hoppers which died, hoppers remaining alive, and the resulting percentages of kill.

Table II (Bait applied Aug. 21).

| Strength of Paris green | Total No. hoppers swept | No. hoppers dying | Hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| ¼ lb. per 25 lbs. bran | 158 | 115 | 43 | 72.7 |
| ½ lb. per 25 lbs. bran | 172 | 136 | 36 | 79.0 |
| ¾ lbs. per 25 lbs. bran | 188 | 138 | 50 | 73.4 |
| 1 lb. per 25 lbs. bran | 136 | 115 | 21 | 84.5 |
| 1¼ lb. per 25 lbs. bran | 236 | 142 | 94 | 60.1 |
| 1½ lb. per 25 lbs. bran | 259 | 173 | 86 | 66.8 |
| Check (Unpoisoned) | 160 | 18 | 142 | 11.2 |
| Totals | 1309 | 837 | 472 | |

Apparently the higher strengths of Paris green do not give as good results as the lower ones. The one pound formula gave the best kill, being 84.5%, but the ½ lb. strength gave 79% kill, there being only 5½% difference. It would appear that the ½ lb. strength is probably more efficient than the 1 pound, since a 5½% increase in kill would not warrant doubling the amount of Paris green at its present price.

TABLE III WHITE ARSENIC (Bait applied Aug. 22).

| Strength of White Arsenic | Total No. hoppers swept | No. of hoppers dying | No. hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| ¼ lb. per 25 lbs. bran | 191 | 78 | 113 | 40.8 |
| ½ lb. per 25 lbs. bran | 145 | 113 | 32 | 77.9 |
| ¾ lb. per 25 lbs. bran | 154 | 140 | 14 | 90.9 |
| 1 lb. per 25 lbs. bran | 201 | 169 | 32 | 84.0 |
| 1¼ lb. per 25 lbs. bran | 141 | 107 | 34 | 75.8 |
| 1½ lb. per 25 lbs. bran | 197 | 161 | 36 | 81.7 |
| 1¾ lb. per 25 lbs. bran | 151 | 107 | 44 | 70.8 |
| 2 lbs. per 25 lbs. bran | 170 | 136 | 34 | 80.0 |
| 2¼ lbs. per 25 lbs. bran | 174 | 129 | 45 | 74.1 |
| 2½ lbs. per 25 lbs. bran | 166 | 145 | 21 | 87.3 |
| Check (unpoisoned) | 154 | 9 | 145 | 5.8 |
| Totals | 1844 | 1294 | 550 | |

The results of these experiments show the usual formulae which contain white arsenic as the poisoning element are stronger than necessary. Here ¾ lbs. per 25 lbs. of bran gave the best kill, it being even better than any of the higher strengths. The check hoppers showed a 5.8% mortality during the six days of captivity.

TABLE IV CRUDE ARSENIC (Bait applied Aug. 27).

| Strength of crude arsenic | Total No. hoppers swept | No. hoppers dying | No. hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| ¼ lb. per 25 lbs. bran | 211 | 114 | 97 | 54.0 |
| ½ lb. per 25 lbs. bran | 283 | 149 | 134 | 52.6 |
| ¾ lb. per 25 lbs. bran | 29 | 209 | 87 | 70.6 |
| 1 lb. per 25 lbs. bran | 234 | 155 | 79 | 66.2 |
| 1¼ lb. per 25 lbs. bran | 245 | 177 | 68 | 72.2 |
| 1½ lbs. per 25 lbs. bran | 181 | 138 | 43 | 76.2 |
| 1¾ lbs. per 25 lbs. bran | 186 | 144 | 42 | 77.4 |
| 2 lbs. per 25 lbs. bran | 201 | 141 | 60 | 70.1 |
| 2¼ lbs. per 25 lbs. bran | 116 | 72 | 44 | 62.0 |
| 2½ lbs. per 25 lbs. bran | 186 | 138 | 48 | 74.2 |
| Check (Unpoisoned) | 242 | 12 | 230 | 4.9 |
| Totals | 2381 | 1449 | 932 | |

From this table we find that 1¾ lb. rate gave the best kill but the 1½ lb. rate was only 1.2% below it. Because of this the 1½ lb. strength might well be recommended when crude arsenic is used in grasshopper baits, although satisfactory results were obtained from all strengths above and including ¾ lb. Only 4.9% of the check hoppers died during the six day period in captivity.

## Rate of Application

In determining the rate to apply poison bran mash to obtain the best results, a series of experiments was planned whereby poison bran mash was mixed with the various arsenicals at their optimum strengths as determined above. Data were obtained by the method previously described. Each series of experiments was run in duplicate, the combined results of which are shown in the following tables.

Table V Paris Green (Bait applied Sept. 21.).

| Rate of application (wet weight) | Total No. hoppers swept | No. hoppers dying | No. hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| 5 lbs. per acre | 149 | 81 | 68 | 54.3 |
| 7½ lbs. per acre | 186 | 115 | 71 | 61.8 |
| 10 lbs. per acre | 187 | 118 | 69 | 63.1 |
| 12½ lbs. per acre | 163 | 103 | 60 | 63.1 |
| 15 lbs. per acre | 192 | 149 | 43 | 77.6 |
| 17½ lbs. per acre | 197 | 141 | 56 | 71.5 |
| 20 lbs. per acre | 203 | 146 | 57 | 71.9 |
| Totals | 1277 | 853 | 424 | |

It will be seen that the 15 lbs. rate gave noticeably better results than any of the rest. The lower rates gave comparatively poor kills in every case.

In sweeping hoppers for the check cage in this series of experiments a number of poisoned hoppers were included, due to some slight confusion existing in the fields in which the experiments were conducted. this also occurred in the experiments, the results of which are shown in Table VI. Because of this the checks were omitted from these two series of experiments.

Table VI White Arsenic (Poison mash applied Sept. 3).

| Rate of application (wet weight) | Total No. hoppers swept | No. hoppers dying | No. hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| 5 lbs. per acre | 167 | 132 | 35 | 79 |
| 7½ lbs. per acre | 159 | 152 | 7 | 95.6 |
| 10 lbs. per acre | 124 | 119 | 5 | 95.9 |
| 12½ lbs. per acre | 136 | 115 | 21 | 84.5 |
| 15 lbs. per acre | 94 | 82 | 12 | 87.2 |
| 17½ lbs. per acre | 104 | 84 | 20 | 80.7 |
| 20 lbs. per acre. | 115 | 104 | 11 | 90.4 |
| Totals | 899 | 788 | 111 | |

TABLE VII CRUDE ARSENIC (Bait applied Sept. 24).

| Rate of application (wet weight) | Total No. hoppers swept | No. hoppers dying | No. hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| 5 lbs. per acre | 171 | 145 | 26 | 84.8 |
| 7½ lbs. per acre | 188 | 168 | 20 | 89.3 |
| 10 lbs. per acre | 177 | 152 | 25 | 85.8 |
| 12½ lbs. per acre | 179 | 147 | 32 | 82.1 |
| 15 lbs. per acre | 179 | 140 | 39 | 78.2 |
| 17½ lbs. per acre | 189 | 144 | 45 | 76.2 |
| 20 lbs. per acre | 186 | 152 | 34 | 81.7 |
| Check (unpoisoned) | 372 | 44 | 328 | 11.8 |
| Totals | 1641 | 1092 | 549 | |

In this case 7½ lbs. and 10 lb. rates gave almost perfect kills, both being noticeably better than the others, although excellent kills were obtained from all the various rates of sowing.

From these data it will be seen that the 7½ lb. and 10 lb. rates gave the best kill; even the 5 lb. rate gave excellent results. The check showed a 11.8% mortality during the six days in captivity.

The following table shows a summary of the three series of experiments shown in tables V, VI and VII.

TABLE VIII

| Rate of application | Total No. hoppers swept | No. hoppers dying | No. hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| 5 lbs. per acre | 487 | 358 | 129 | 73.5 |
| 7½ lbs. per acre | 533 | 435 | 98 | 81.6 |
| 10 lbs. per acre | 488 | 389 | 99 | 79.7 |
| 12½ lbs. per acre | 478 | 365 | 113 | 76.3 |
| 15 lbs. per acre | 465 | 371 | 94 | 79.7 |
| 17½ lbs. per acre | 490 | 369 | 121 | 75.3 |
| 20 lbs. per acre | 504 | 402 | 102 | 79.7 |
| Check (Unpoisoned) | 372 | 44 | 328 | 11.8 |
| Totals | 3817 | 2733 | 1084 | |

Consulting the above table we find that very little difference exists in the percentage of kill obtained from applying poison bran mash at different rates per acre. The 5 lb. rate fell somewhat below the rest, apparently being a little too thin. The 7½ lb. rate gave slightly the best results although little better than the higher rates. From the results here obtained a general recommendation to apply bran mash

at the rate of from 5 to 10 lbs. per acre might well be made. This is about as thinly as the average person can apply it by hand and cover the ground uniformly,

## Comparative Value of Poisons

The optimum strength of the various arsenicals in poison bran mash and the optimum rate of application in the field, having been determined to the writers' satisfaction, it was decided to learn, if possible which arsenical is most effective in grasshopper control. Accordingly a series of experiments were outlined whereby the three common arsenicals, namely Paris green, white arsenic and crude arsenic, were run under similar conditions and in each case at their optimum strength and rate. Quarter acre plots were treated with the various mixtures and the hoppers swept therefrom handled as has been previously explained.

The following table which includes the results of 8 series of experiments in which the three arsenicals were run, shows the date, poison, number of hoppers swept, number of hoppers which died, the number of hoppers remaining alive, and the percentage of kill.

Table IX

| Date | Poison | Total No. hoppers swept | No. hoppers dying | No. hoppers remaining alive | Percentage of kill |
|---|---|---|---|---|---|
| Aug. 18 | Paris green | 90 | 52 | 38 | 57.7 |
| | White arsenic | 39 | 23 | 16 | 58.9 |
| | Crude arsenic | 52 | 30 | 22 | 57.6 |
| Aug. 18 | Paris green | 96 | 73 | 23 | 76.0 |
| | White arsenic | 65 | 36 | 29 | 55.4 |
| | Crude arsenic | 63 | 45 | 18 | 71.4 |
| | Check (Unpoisoned) | 155 | 8 | 147 | 5.1 |
| Sept. 8 | Paris green | 36 | 24 | 12 | 66.6 |
| | White arsenic | 49 | 26 | 23 | 53.0 |
| | Crude arsenic | 44 | 26 | 18 | 59.1 |
| Sept. 8 | Paris green | 42 | 21 | 21 | 50.0 |
| | White arsenic | 50 | 29 | 21 | 58.0 |
| | Crude arsenic | 54 | 30 | 24 | 55.5 |
| Sept. 8 | Paris green | 43 | 28 | 15 | 65.1 |
| | White arsenic | 42 | 30 | 12 | 71.4 |
| | Crude arsenic | 42 | 22 | 20 | 52-4 |
| Sept. 8 | Paris green | 39 | 21 | 18 | 53.8 |
| | White arsenic | 54 | 35 | 19 | 64.8 |
| | Crude arsenic | 50 | 34 | 16 | 68.0 |
| | Check | 126 | 16 | 110 | 12.2 |
| Sept. 12 | Paris green | 60 | 49 | 11 | 81.6 |
| | White arsenic | 66 | 45 | 21 | 68.2 |
| | Crude arsenic | 57 | 43 | 14 | 75.4 |
| Sept. 12 | Paris green | 54 | 41 | 13 | 75.9 |
| | White arsenic | 61 | 47 | 14 | 77.0 |
| | Crude arsenic | 58 | 39 | 19 | 67.2 |
| | Check | 128 | 14 | 114 | 10.9 |
| | Totals | 1715 | 887 | 828 | |

This series of experiments shows the variation in kill received from the different poisons for the several dates on which the poison was applied. In order to come to a definite conclusion it is necessary to combine all tests on each poison under one head. This is shown in the following table.

TABLE X

| Poison | Total No. hoppers swept | No. hoppers dying | No. hoppers remaining alive | Percentage of kill. |
|---|---|---|---|---|
| Paris green | 460 | 309 | 151 | 67.1 |
| White arsenic | 426 | 271 | 155 | 63.6 |
| Crude arsenic | 420 | 269 | 151 | 64.0 |
| Check | 409 | 38 | 371 | 9.2 |
| Totals | 1715 | 887 | 828 | |

When Paris green, white arsenic, or crude arsenic are used at their optimum strengths and applied at the optimum rates, it would seem that one is practically as good as the other. In these eight series of experiments there was only 3.5% variation in the percentage of kill. Although rather poor kills were obtained in the experiments shown in Table IX, due to lateness of the season, the comparative results are fairly accurate since all poisons were applied under similar conditions.

## SUMMARY

1. Black strap molasses gave much better results than any of the other syrups used.
2. The optimum strengths for the three standard poisons was found to be, Paris green ½ lb., white arsenic ¾ lb., and crude arsenic 1½ lb. per each 25 lbs. of bran.
3. The optimum rate of applying poison bait was found to be 7½ lbs. of the wet mash per acre, however, a general recommendation of from 5 to 10 lbs per acre might well be made.
4. There was very little difference in the three arsenicals when run under similar conditions at their optimum strengths and rates.

# OBSERVATIONS ON THE FALL ARMY WORM (*LAPHYGMA FRUGIPERDA* Smith & Abbott) AND SOME CONTROL EXPER IMENTS[1]

By Roger C. Smith, *Assistant Entomologist, Kansas State Agricultural Experiment Station*

Early in September 1920, larvae of the fall army worm suddenly appeared in large numbers in various localities in the central and east central parts of this state. Inquiries began to come in on September 9th and by the 12th their injury to alfalfa was quite apparent at Manhattan. The outbreak was not general, but scattered and confined to occasional fields.

There were three primary areas of infestation in the state. First, the largest one, in south central Kansas, comprising Barber, Harper, Sumner, Cowley, Chautauqua, Kingman, Sedgwick, and Reno Counties. The second was that about Manhattan, comprising the counties of Riley, Clay, Geary, Pottawatomie, and the northern part of Morris County. The third comprised Anderson and Coffey Counties. The larvae were first seen defoliating volunteer wheat and oats, then upon young alfalfa which had been sown after harvest, and finally defoliating alfalfa which was not quite ready for the fourth cutting. Correspondents reported that entire fields of volunteer wheat as large as 140 acres were eaten bare by the larvae. In all alfalfa fields seen, the damage was localized in the field. There were several fields of alfalfa on the college farm severely attacked, and it was in these fields that most of the observations herein reported were made.

The history of former outbreaks has been well given by Chittenden (1901)[2] and Hinds and Dew (1915).[3] In this state this insect is not an annual pest, the last outbreak occurring in the fall of 1911. From the records of this station, it has apparently not since occurred in numbers until this fall.

The nature of the recent outbreak, and the conditions leading up to it, were typical, judging from the published accounts. Last win-

[1]Contribution No. 64 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in the prosecution of project No. 115 of the Kansas Experiment Station.

[2]Chittenden, F. H., 1901. Fall Army Worm and Variegated Cutworm. Bul. 29, N. S. Div. of Ent. U. S. Dept. Agr. pp. 13-45.

[3]Hinds, W. E., and Dew, J. A., 1915. The Grass Worms or Fall Army Worms. Alabama State Agr. Exp. Sta. Bul. 186, pp. 59-92.

ter was unusually dry and the rainfall in the spring somewhat below normal. There was little rain until after harvest, when the precipitation during the month of August was unusually heavy. As a result of this, there was much volunteer wheat and oats over the state and in newly sown alfalfa fields which followed wheat. There was also a heavy growth of crab grass, foxtail, and similar grasses. Alfalfa likewise made a heavier growth than had either of the two previous cuttings.

In all infested fields seen, the larvae began their destructive work in a small spot, and then worked outward over a fanshaped area, or, under certain conditions, in all directions. In some fields, the volunteer wheat around a straw stack was their starting point. At the college, the larvae appeared at one side of the fields, generally at one of the lowest spots. As food became scarce they spread out over the field, leaving the alfalfa and grasses in the fields completely defoliated.

The larvae fed first on the young leaves at the crown of the alfalfa plants, then climbed up the plant, defoliating as they went, and devouring the uppermost leaves last. They climbed up the plants and began feeding about three o'clock on clear days, while in the morning there were only a few larvae upon the plants. During the day, most of the larvae rested at the crown of the plant, under the dried leaves or other trash, under clods or the loose earth. When the plants were jarred, as when one walked through the field, or when bran mash struck the plants, the larvae dropped to the ground. They generally dropped also when attacked by the Tachinid flies, probably as a protective measure, but the flies usually followed and often deposited their eggs on them. Their work was evident first where the alfalfa was thinnest on the ground Since there was less food in such places per unit of area, their migration was most rapid here. This explained, to some extent at least, the peculiar contour of the defoliated areas in some of the fields.

The larvae disappeared almost as suddenly as they came. By the twenty-third of the month, practically all larvae were full grown, and they were very scarce on the twenty-fifth. Larvae collected when the outbreak was first noticed were all prepupae or pupae on the twenty-fifth. In two days more there was only an occasional larva to be found.

The first adults appeared in rearings on September 30th. By October 7th, about half of the reared pupae had yielded adults. It was concluded that the maximum emergence of moths in the field occurred on this date. They appeared to be about as numerous as the larvae

had previously been. When disturbed they flew a short distance with the wind and nervously sought shelter in some clump of alfalfa or grass. Many had one or more of their wings crumpled, caused probably from emerging through the hard soil. Moths from reared larvae were mated in laboratory cages, and on October 9th several egg masses were obtained from moths which emerged October 3rd. From this time on, egg masses were obtained nightly until October 22nd. A careful search was made almost daily for egg masses in the field, but only one was found. It was found October 18th on the under side of a leaf of a young oak tree in a small patch of alfalfa. The eggs were fertile and hatched on October 20th. One larva was taken by sweeping during the month of October. It was surprising that so few eggs and larvae were found after such a large emergence of moths. Both collected and newly emerged moths from rearings failed to deposit eggs in out door field cages. The batches deposited in confinement all hatched, the fertilty as shown by two large batches apparently typical being 84 per cent. The interval between oviposition and hatching in indoor laboratory rearings was from three to four days.

Some of the larvae hatching in the laboratory were placed on alfalfa in out door cages to see if another generation could be reared. They fed to some extent but the heavy frosts the latter part of October probably killed them. At least on November 20th, it was concluded that all larvae in the four cages were dead, thereby apparently eliminating the possibility that they might over-winter as partly grown larvae.

On several occasions, small plats in areas where larvae had been most abundant were dug up in search of live pupae overwintering. None were found, but many empty pupal cases were seen. They were located from about three inches below to just beneath the surface. The very hard soil apparently prevented many from going to the greater depth. Dipterous larvae, probably parasitic, were found during the digging, overwintering as larvae. An effort is being made to carry living pupae through the winter, but the general concensus of opinion, however, appears to be that they do not ordinarily winter successfully as pupae in this latitude, but that the moths migrate northward from the south in the spring.

Sowing poisoned bran mash as in the control of the true army worm has been recommended for the control of this insect. During the short period this outbreak was in progress, it was decided to test the efficiency of the well known Kansas bran mash as a control measure and to compare with it certain modifications of the regular formula. Recent work with the substitution of sawdust for bran with other insects

suggested a trial with this one. Table I gives a list of the plats sown and the percent of control obtained based on counts of living and dead larvae. Conditions in the alfalfa fields where these plats were located were very similar if not identical. Death of larvae, due to natural causes, averaged 3.2 per cent in these plats. The percentages in the table were computed on the total counts of three individuals, the writer having been one of them.

TABLE I - EXPERIMENTS AND PERCENT OF CONTROL OBTAINED

| Plat No. | Pcison used | Saw-Dust Pounds | Bran Pounds | Molasses Pints | Lemons | Water Approx. Gallon | Date Sown | Percent of larvae dead 24 hrs. | 48 hrs. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | ¼ lb. Paris green | 5 | 0 | 1 | 0 | 1 | 9-16 | 51.5 | 35.3 |
| 2 | ½ lb. Pow'd. Ar. of Lead | 5 | 0 | 1 | 1 | 1 | 9-16 | 10.0 | 8.2 |
| 3 | ¼ lb. Paris green | 0 | 5 | 1 | 1 | 1 | 9-14 | 81.3 | 93.5 |
| 4 | Arsenic[1] in citrus pulp | 0 | 5 | 0 | 0 | 1 | 9-16 | 19.6 | 15.6 |
| 5 | ¼ lb. Paris green | 5 | 0 | 1 | 1 | ⅞ | 9-17 | 21.7 | 20.8 |
| 6 | ¼ lb. Paris green | 0 | 5 | 1 | 0 | ⅞ | 9-17 | 86.6 | 92.4 |
| 7 | ¼ lb. Paris green | 0 | 5 | 1 | 2 | ⅞ | 9-20 | 88.0 | 97.1 |
| 8 | Arsenic in citrus pulp | 0 | 5 | 0 | 0 | 1 | 9-20 | 2.9 | 15.7 |
| 9 | ¼ lb. Paris green[2] | 0 | 5 | 1 | 0 | ⅞ | 9-20 | 99.6 | 99.5 |
| 10 | 1 lb. Paris green | 0 | 20 | 4 | 3 | 3½ | 9-18 | | 92.1 |
| 11 | Check Plat | 0 | 0 | 0 | 0 | 0 | 9-18 | 3.2 | |

[1]A commercial preparation, made by the Exchange Orange Products Co. One-fifth of a can was used.
[2]Larvae were rapidly entering ground for pupation at this time.

The regular bran mash mixture made with Paris green gave excellent results. It is interesting to note that this mixture gave approximately the same results where the lemons were used according to the formula, where omitted, and where the number was doubled. It was observed that dead larvae were more often found where bran mash particles could be seen on the ground. A lower percent of control was obtained on the plats where sawdust was substituted for bran. The sawdust mixtures were distinctly less palatable to the larvae. It was a common occurrence to see larvae crawl over these mixtures without feeding, but in the case of the regular bran mash, they fed much more freely. The sawdust, however, was not above criticism. It was obtained at the college carpenter shop and consisted of a variety of kinds, pine probably predominating. In addition to the probable repellent odor of pine, some of it was somewhat coarser than desired.[3]

[3]Davis, J. J., and Turner, C. F., 1918. Experiments with Cutworm Baits. Canadian Ent., 50:187-192.

The only experiments with white arsenic were the two plats sown with a commercial citrus fruit pulp mixture (Mackie, 1920),[4] diluted with bran, but a poor killing was made in both cases. In fairness, it should be stated that this preparation is recommended by the manufacturers as a grasshopper poison. While the results on these two plats were almost identical, they are not regarded by the writer as conclusive. Perhaps the conclusions of Davis and Turner (loc.cit.) to the effect that white arsenic was less effective than Paris green with the true army worm are evidenced here in these results with this insect.

Some confusion developed during this outbreak over the terms "white arsenic" and "lead arsenate", or "arsenate of lead." In several instances arsenate of lead was sold instead of arsenic, and was mixed in the bran mash at the proportions prescribed for arsenic. Two sowings of this mixture failed to check the larvae appreciably. In one instance, paste arsenate of lead was sold a farmer in place of arsenic without explaining the substitution. Paris green has an advantage of not being readily mistaken for other substances, and in the mixing shows up well on the bran flakes.

Parasitic Tachinid adults were plentiful at all times during this outbreak, but the percentage of larvae with the ivory white eggs on their bodies varied greatly between fields. In one field, early in September, a parasitism of about 95 per cent was found. On the college farm, at the same time, the parasitism was four per cent, but later increased to about 50 per cent. *Winthemia quadripustulata* Fabr., was the more common Tachinid in the fields. About 80 adults of *Muscina stabulans* Fall. emerged from 100 fall army worm larvae collected in the field and placed in a jar for rearing parasite adults. Dr. Aldrich states with the determination of the specimens that "the larvae according to Keilin is saprophagous until near the end of the second stage, then becoming predaceous on other dipterous larvae. It is not a parasite, but the fly lays its eggs where there are other dipterous larvae." It is believed that relatively few larvae bearing Tachinid eggs upon their bodies died as a result of the parasitic larvae. It is well known that if the host molts before the parasite egg hatches, the egg is discarded with the molt. It is doubtful if the larva into which the parasitic larva has entered takes any food thereafter.

It was found that when larvae bearing eggs of Tachinidae upon their bodies are killed by poisoned bran mash that the parasites did not develop. There were no exceptions in a batch of 100 larvae, i.e., no para-

[4]Mackie, D. B., 1920. A Prepared Grasshopper Poison. Monthly Bul. Dept. Agri. Cal. IX, No. 5-6, pp. 194-197.

site adults developed from the lot. It was further found that larvae are rarely if at all poisoned by feeding upon a larva which has died from eating poisoned bran mash. In a series of 77 larvae, of which five ate all of a dead larva and died; 29 ate all and lived. The increase in the death rate over the check was 1.7 per cent, an increase so small that it might be otherwise explained.

## Summary

An outbreak of the fall army worm occurred in central and east central Kansas in September, 1920. Only occasional fields were attacked and frequently only parts of these were defoliated. The larvae were first seen defoliating volunteer wheat and oats, but soon appeared in alfalfa fields where the real damage was done. The moths emerged in the field early in October, but very few eggs were deposited. Control experiments with the poisoned bran mash made with Paris green gave satisfactory results. Sawdust substituted for the bran was less attractive to the larvae, and a lesser killing was made.

# Scientific Notes

**Harlequin cabbage bug in South Dakota.** The Harlequin cabbage bug (*Murgantia histrionica* Hahn) has established itself in South Dakota and has already proven to be a serious pest in its new home. Our attention was called to this pest for the first time in 1919. During this year complaints regarding the injurious work of this bug came to us chiefly from the lower central portion of South Dakota. In 1920 the injury was much more serious and extended thru central South Dakota, from the southern border almost to the northern. Cruciferous plants were most generally injured, but potatoes, tomatoes, beans, beets, squash, pumpkin, corn, plum trees and even cottonwoods were reported to have suffered.

H. C. Severin,
*State Entomologist, Brookings, S. D.*

**Peach Seedlings Attacked by Dipterous Larvae.** On March 14, 1921 some peach seedlings infested with dipterous larvae and puparia were received from H. N. Shamburger Nursery Company, Myrtle Springs, Van Zandt County, Texas. This material was placed in a rearing cage and the first adult flies appeared on March 22. The flies were identified by Dr. Aldrich as *Hylemyia cilicrura* Rd. (*Phorbia fuscíceps*, Zett of authors). Dr. Howard states that this species is supposed to be identical with the seed corn maggot (*Anthomyia zeae*,Riley).

The following extracts relative to the injury are taken from a letter received April 6, 1921, from the proprietor of the Nursery:

"We first notice that the plant looks sick, it ceases growing, gradually turns pale yellow in color and finally withers up and dies.* About 25% of all our seedlings at one time seemed to be affected, however, not all of these have died yet."**

"This is the first time we ever had trouble with this pest. It is entirely new to us."

"**Nothing else in our Nursery is affected."

"We have examined hundreds of seedlings and these maggots have been found in the seed only, none feeding on the stem."

"***A small quantity of seed from the same pit, planted about 15 days earlier than the main crop on the land adjoining, and not more than 1% of these were affected.***"

No further reports of any additional infestations have been received.

H. J. Reinhard,
*College Station, Texas*

**The Stanford Collection of Coccidae.** The already extensive collection of Coccidae in the Department of Entomology at Stanford University, has received some very important additions during the past year. Mr. A. H. Hollinger has generously given to the department his collection of Coccidae from Texas, consisting of approximately 1000 lots. The work that has been done on this collection shows that it contains many interesting and important species.

Mr. O. E. Bremner, County Horticultural Commissioner for Sonoma County, and Mr. R. S. Woglum for many years connected with the Bureau of Entomology, now Entomologist for the California Fruit Growers Exchange, have both loaned their extensive collections of Coccidae to our Department in order that they may become available for study by specialists in this group. These collections represent the results of many years work and they are especially valuable because they contain so many species from various parts of the world. The Bremner collection is of particular interest from the presence in it of type material of numerous species described by Maskell and Cockerell.

These, with the collections recently made by Mr. Ferris in Lower California and the Southwestern United States, and the material that has been received by exchange from foreign coccidologists, make the Stanford Coccid collection second in importance in the Uuited States only to the National Collection at Washington. The types of all of the species that have been described (approximately 100) from this laboratory, are deposited here.

The work of publishing the results of the studies on the collection is being, and will continue to be, pushed as rapidly as possible.

R. W. Doane

**An Unusual Type of Injury to Sweet Potatoes in Texas by a Burrowing Bee.** July 28, 1920, the writer received word from a farmer in Ricardo, Tex., that a new insect, which resembled a bee, was injuring sweet potatoes and that the pest was present by the thousands or millions. As the grower had not been able to irrigate, the plants were gradually drying up. The writer, upon investigation, found the field alive with bees, swarming in the air and on the ground. Many were just emerging from the soil while others appeared to be "digging in." The ground in spots was honeycombed with burrows made by the emerging bees, identified by Mr. S.

A. Rohwer as *Nomia nortoni* Cress. Emergence was at first localized, but in a few days the bees appeared in all parts of the fields, although more numerous in some places than others. Maximum abundance continued for about a week, after which their number gradually decreased. All were gone in about 15 days, disappearing as suddenly as they had appeared. The report of the grower as to the condition of the sweet potato crop was found to be correct. The plants were somewhat shriveled and plainly showed the lack of moisture. On the side of the field first attacked by the bees they had assumed a yellowish appearance. Some were almost uprooted by the bees in their mining.

*Nomia nortoni* is slightly larger and darker than the honey bee. Unlike many mining bees, it does not construct common burrows with branches terminating in a single cell. These tunnels more often than not terminate in a single nest which consists of from 4 to 12 cells, the majority examined containing 6 to 8 cells. Most of the burrows ran perpendicularly into the ground for from 8 to 48 inches, usually ranging from 18 to 24 inches in depth. Only two burrows were found as deep as 48 inches. Three instances were observed where the same tunnel from the surface appeared to have been used as a passage from two nests, the second nest being about 8 inches directly below the first. The writer cannot be positive as to this, however, as the nature of the soil and the close proximity of the burrows rendered difficult the tracing of any single tunnel all the way down to the nest. At the bottom of the burrow, the nest proper was held in a pocket-like cavity, the walls of which were at such distance from the brood cells as to render each readily accessible. It was constructed of moistened and kneaded earth, irregular in outline and about the size of a lemon. The walls of each cell in the nest had been tightly sealed and glazed. A few dead bees were found in the cells, although the majority were empty.

The writer has been unable to find the new home of these bees, but it is evident that they did not deposit all over this plot, for no trace of bees was found in the several holes that were dug. No doubt with the aid of a steam shovel the bees could be located in a short time to ascertain the stage present at this time. The nests appeared to have been tightly sealed before the bees emerged and their construction showed that the builders possessed some ingenuity. The writer hopes that he may be able to secure more data on this insect at a later date. The bees caused the sweet potato crop in this locality to be a total failure. The plot could not practically be irrigated from the small well after the bees had finished with their tunneling of the soil, as the plat was a sandy loam soil underlaid with a stratum of "caliche" (limestone) that would take up the water faster than it could be applied. The bees did no other injury to the sweet potatoes than filling the soil full of burrows, which prevented irrigation and later caused the plants to dry up.

The pest was injurious to sweet potatoes in this locality in 1915, but at that time the writer was able to secure only a single specimen, as the bees had practically disappeared when he arrived on the ground. It appears that the bee prefers to deposit in soil that has been irrigated since no report has been received of it doing damage to non-irrigated soil.

M. M. High

*Entomological Assistant, Truck Crop Insect Investigations, United States Department of Agriculture*

**Subcortical Temperatures of Logs Exposed to Direct Sunlight.** During the past year the attention of entomologists has been called to the fact that the temperature

beneath the bark of logs lying in full sunlight may reach a degree fatal to insects.[1] Craighead working with ash logs in several localities in the South observed subcortical temperatures which exceeded air temperature by 60° (F?) depending upon the locality, condition of the sky and angle of the sun's rays. On the basis of his experiments he recommends the weekly turning of logs to protect them from wood destroying insects.

So far as some species of logs are concerned, the author has independently reached similar conclusions from work conducted at the Minnesota Experiment Station. But these experiments have also shown that, in northern latitudes at least, some logs never reach the fatal temperature for insects even on the brightest days. Thus it is essential that the factors influencing the subcortical temperature should be understood if this method of control is to be used intelligently. A more complete discussion of the factors influencing the subcortical temperature of logs will appear in the 18th Report of the Minnesota State Entomologist.

The results thus far obtained may be summarized as follows:

1. In bright sunlight subcortical temperature on the upper side of moderately thin barked logs often passes above a point fatal to insects.

2. That this is not true of all logs is illustrated by certain thin barked Norway pine logs, the subcortical temperature of which never exceeded 46°C during the entire summer season of 1920.

3. One of the primary factors influencing the temperature in logs is solar radiation. The effect depends upon light intensity, solar altitude and the angle of incidence of the sun's rays upon the log.

4. The position of the log with reference to the sun's rays determines the proportion of the log which may attain a high temperature. Logs lying east and west will have heated only a comparatively narrow strip on the south side while almost one-half of the log lying north and south may exceed the fatal temperature of insects.

5. The bark characteristics which affect log temperatures are: (a) Color. Dark bark absorbes heat much more rapidly than light colored bark. (b) Surface. Rough bark provides a larger absorbing and radiating surface than smooth bark and gives higher temperatures, provided the angle of incidence is not great. (c) Structure. Scaly bark is a better non-conductor than bark of a uniform dense structure and therefore tends to hold down temperature. (d) Thickness. This tends to increase insulation.

6. In absence of solar radiation the subcortical temperature follows rather closely the temperature of the surrounding air.

7. The conduction of heat around a log is slow, but varies somewhat with the different species. This results in the concentration of heat in limited areas.

8. Air movement tends to increase radiation and therefore tends to reduce subcortical temperatures.

9. Evaporation of water from the surface layers of the bark, which often occurs in the early morning or following rain tends to reduce the temperature beneath the bark.

10. Close proximity to other radiating or absorbing surfaces tends to stabilize subcortical temperature.

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[1]F. C. Craighead (1920) Direct Sunlight as a Factor in Forest Insect Control. Proc. Ent. Soc. of Wash., Vol. 22, pp. 106-108.

S. A. GRAHAM

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1921

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**It is perhaps unnecessary to state that the appearance of this issue has been greatly delayed by the printers' strike. The August number is now in press and may be mailed shortly.**

The Insect Pest Survey recommended by the association at its last meeting is an accomplished fact and the first two issues of the monthly Bulletin and a number of special Reports give a more definite idea of possibilities than could be obtained from any general discussion of plans. The survey organization affords a ready means of picturing the seasonal developments of the country and as a whole it will be of value in proportion to the cooperation it receives.

It has started excellently and it remains for those who advocated the departure to give such support that there can be no question as to the merits of the undertaking. Insect life recognizes no political boundaries and is very subject to local and more or less irregular, frequently poorly understood fluctuations. One problem of the survey is to accumulate all such data and as general tendencies become better known, the probabilities of utilizing them in practical ways are greatly increased. The survey may be characterized as a nation-wide attempt to cooperate along scientific lines. It can succeed only through mutual service. The men in the field must provide data,—there can hardly be too much. Those in charge must see that the information is promptly distributed in a convenient form. As a consequence of organizing this survey, every man's work will have a perspective not heretofore possible in many instances. There are also great possibilities in the proposed annual digest and later, as data accumulate, in the recognition of distinct tendencies in various sections. The successful control of insect

life depends upon exact knowledge of the behavior of insects. There have been in recent years many close studies of individual insects or groups of insects for the purpose of obtaining such data. The Insect Pest Survey has opened up a line of investigation capable of rendering great, possibly greater service than the study of restricted problems, though both are essential to material advances along progressive lines.

## Reviews

**Report of the Proceedings of the Third Entomological Meeting held at Pusa, 3rd to 15th February, 1919,** edited by T. Bainbrigge Fletcher, 3 vols. pages 1-1137, 182 plates (many colored), Calcutta, Superintendent Government Printing, India, 1920

This set of volumes is a magnificent contribution to our knowledge of Indian insects and reflects great credit upon all participating in the conference. Nearly three hundred (300) pages are devoted to an annotated list of Indian crop pests and such unusual subjects, from the American view point, as methods of storing grain, Lantana insects and Lac production receive attention in addition to the numerous notes concerning a very large number of insects, a few of which are known as pests in this country, though most represent an entirely different fauna.

These volumes are a mine of information and though dealing with insects of a totally different section of the world, contain much of interest to American Entomologists.

E. P. F.

**Insect Pests of Farm, Garden and Orchard** by E. Dwight Sanderson, revised by L. M. Peairs, pages I-VI, 1-707, 604 text illustrations, John Wiley & Sons, Inc., New York, 1921.

This is a revised and enlarged edition of the senior author's well known work published under the same title in 1912. The revision has been directed mainly toward bringing control measures up to date, though there have been modifications of the text and important additions, particularly the chapters in relation to insects injurious to citrus fruits, to man and in the household and to domestic animals and poultry. The chapter on insects affecting hops of the first edition has been eliminated and the account of the hop plant louse as a plum pest considerably reduced and the discussions of other hop insects discarded, presumably because of their relatively slight importance so far as the country as a whole is concerned. Can this be an indirect outcome of the Volstead Act? The authors have rendered a distinct service by reproducing in permanent form a number of the diagrammatic illustrations of the life history and activities of important insects issued during recent years by the Federal Bureau of Entomology, though the reductions of certain posters have of necessity been somewhat greater than was desirable

The authors gave nothing as to the value of corrosive sublimate for the control of cabbage maggot and the efficacy of timely sprayings with ordinary arsenicals

for checking the apple maggot. Both of these are somewhat recent developments and may not have become sufficiently established before the forms for these particular chapters were closed. The volume bears the date of 1921 and although the preface is dated May 1920, it would have been desirable, in the opinion of the reviewer, to have included a brief statement of the noteworthy extensions of infested territory by both European Corn Borer and Gipsy Moth known by mid-summer 1920. A study of a general infestation by wheat midge leads the reviewer to place little dependence on the remedial measures outlined for this insect, tho these are based upon well accepted literature of the past and at the present time nothing very definite can be advised.

The earlier edition was a most excellent and exceedingly helpful digest of the then known entomological facts. This revision with its greatly increased number of illustrations, is destined to be the most convenient and reliable, general work for some years to come. It will be exceedingly serviceable to both Entomologists and Agriculturists and should be available to all interested in the control of the numerous insects affecting the varied crops of America.

E. P. F.

## Current Notes

Mr. A. F. Burgess addressed the meeting of Local Moth Superintendents at Boston, March 23.

The semi-annual meeting of the Nova Scotia Entomological Society was held in Halifax, February 9.

Miss Evelyn Osborn is now professor of entomology in the Agricultural College, Syracuse University, Syracuse, N. Y.

Mr. W. S. Blatchley of Indianapolis, Ind., spent the winter at his winter home in Dunedin, Fla.

The twelfth annual meeting of the British Columbia Entomological Society was held in Vancouver, on February 12.

According to *Science*, Dr. Walter E. Collinge, of St. Andrews University, has been appointed keeper of the York Museum.

Mr. H. L. Seamans has been appointed provincial entomologist for Alberta, B. C., and reported at Lethbridge, March 30.

Sixty students are now enrolled in the course in beekeeping given to the vocational students in agriculture by Mr. Frank S. Stirling at the University of Florida.

Mr. U. C. Loftin has resigned from the Bureau of Entomology to accept a position as entomologist with a cotton company operating in the Laguna district of Mexico.

Mr. E. H. Strickland of the Canadian Entomological Branch, left Ottawa on February 14, for Alberta, to join the Inter-provincial Weed Train, to give lectures on grasshoppers and cutworms, returning on March 12. During this period he gave 49 lectures to some 4500 people.

According to *Gleanings in Bee Cultura*, the State of Pennsylvania has just enacted a new foul brood law, making it unlawful to ship bees, hives, or appliances into the State, unless accompanied by a certificate of inspection from State or county from where they are shipped.

A bill is now before the Rhode Island Legislature asking for an appropriation of $20,000.00 for the purpose of eradicating mosquitoes in such towns and cities as may appropriate funds for such work.

Mr. T. J. Tothill of the Canadian Entomological Branch, visited Washington, D. C., in March to engage in systematic work at the U. S. National Museum, taking along some Canadian material for comparison.

According to *Science*, Professor George C. Embody has returned to Cornell University, after spending the period since last September establishing at the University of Washington the first college of fisheries in an American University.

Dr. T. J. Headlee appeared by request before the legislative committee on Public Health and Safety at Hartford, Conn.. February 16, to explain the progress and value of anti-mosquito work in New Jersey.

According to *Science*, the death is announced of Professor Louis Compton Miall, F. R. S., formerly professor of biology at the University of Leeds, and author of *Natural History of Aquatic Insects*, at the age of 79 years.

Mr. Loren B. Smith severed his connection with the Virginia Truck Experiment Station at Norfolk, April 1, to accept a position as agent of the U. S. Bureau of Entomology, in charge of biological studies, Japanese Beetle Investigations, at Riverton, N. J.

According to *Science*, Professor Herbert Osborn, of the Ohio State University, has recently returned from a two months' trip to Florida, during which he collected insects at different points in the state in co-operation with the State Plant Board of Florida.

Mr. L. S. McLaine of the Entomological Branch, Ottawa, Canada, attended the meeting of the local Moth Superintendents, and the Massachusetts Tree Wardens' and Foresters' Association, at the Boston City Club, Boston, Mass., March 23. He also visited the corn borer laboratory at Arlington.

Mr. J. E. Graf is now in charge of the field work in the organization which the Bureau of Entomology has established for preventing the spread of the Mexican bean beetle in Alabama. Mr. Neale F. Howard will be in charge of the research work.

Mr. Arthur Gibson, Dominion Entomologist, has recently been appointed a member of the Lyman Entomological Bequest Committee and attended a meeting of the Committee, held at McGill University, Montreal, on February 16.

A Smoker was held by the Florida Entomological Society on January 17th, in honor of Professor Herbert Osborn, who spent a portion of the winter in Florida. Upwards of forty members and invited guests were present, and an enjoyable evening will be remembered by all. Dean Wilmon Newell acted as toastmaster.

Messrs. W. R. Walton, L. H. Worthley and D. J. Caffrey of the Bureau of Entomology visited the European corn borer infestation in western New York on March 21. The corn stalks and stubble have been removed and burned or crushed over an area of nearly 1000 acres in this region.

Dr. E. F. Phillips of the Bureau of Entomology attended a meeting of the Maryland State Beekeepers' Association at Baltimore, March 18, the annual meeting of the West Virginia Beekeepers' Association at Charleston, March 25-26, and a special meeting of the beekeepers' during Farmers' Week at the University of Maine, Orono, on March 30.

At the annual meeting of the Florida Entomological Society held at Gainesville, Jan. 24, the following officers were elected for the year: President, Professor J. R. Watson: Vice-President, P. W. Fattig; Secretary, Jeff Chaffin; Treasurer, Dr. E. W. Berger; Member of Executive Committee, O. F. Burger, Professor Herbert Osborn was elected an honorary member of the Society.

The following transfers have been made recently in the Bureau of Entomology: K. B. McKinney, George H. Bradley, M. T. Young, R. C. Gaines and W. R. Smith have returned to the Bureau from temporary employment by the Federal Horticultural Board; John B. Gill, Brownwood, Texas, temporarily to Fort Valley, Ga.; C. N. Ainslie, Knoxville, Tenn., to Sioux City, Ia.

According to *Entomological News*, Mr. Edward P. Van Duzee, Curator of Entomology at the California Academy of Sciences, left San Francisco, March 30, for Guaymas, Mexico, where he will join an expedition organized by the Academy for the scientific exploration of Lower California and the adjacent islands. He goes as entomologist of the expedition and expects to return to San Francisco in August.

The principal activities in the corn borer investigations in New York State wil be transferred to Silver Creek, at an early date with Mr. H. N. Bartley in charge for the present. Mr. J. H. Harmon has been placed in charge of the operations near Schenectady and will maintain a small force at that point for the purpose of studying the insect in that vicinity.

The following resignations from the Bureau of Entomology have been reported: C. F. Turner, formerly in charge of corn borer investigations, Schenectady, N. Y., to engage in commercial fruit growing at Memphis, Tenn; G. H. Cale, apiculture, to take charge of the Dadant Apiaries at Hamilton, Ill.; L. G. Gentner, truck crop insect investigations, to become an instructor in entomology, Michigan Agricultural College; F. L. O'Rourke, corn borer work, Arlington, Mass.

Dr. W. E. Britton addressed the tenth annual meeting of the Massachusetts Tree Wardens' and Foresters' Association at Boston, March 23, on "Registration of Shade Tree Workers, and Shade Tree Insect Troubles."

Mr. Stephan Keler, Forest Entomologist, Lemberg (Lwow) Tarnowskiego 45, Poland, would like to communicate with American entomologists interested in the Coleoptera of Poland. His specialty is the bark beetles (Ipidae) and he would like to obtain specimens from the United States in exchange for Polish ones. He has also material in other families of Coleoptera, which he will exchange for American (U. S.) literature of Ipidae, s. str., and of forest entomology, s. lat.

Enos B. Engle, chief nursery inspector and oldest member both in years and term of service, of the Bureau of Plant Industry of the Pennsylvania Department of Agriculture, celebrated his eightieth birthday anniversary recently. He is a veteran of the Civil War, remarkably vigorous in both mind and body and has made a record worthy of emulation by youngsters of seventy-five or less.

*Entomological News* records the death on October 25, 1920, at Florence, Italy, of Dr. Odoardo Beccari, and of Professor Tsunekata Maiyake, of the Agricultural College of the Imperial University of Tokio, Japan, in February 1921. Dr. Beccari was director of the Botanical Garden, but from 1865-1876 he explored Indo-Malaysia and Papua and collected many insects; he has published an account of the formicary plants of Malaysia and Papuasia. Professor Maiyake is the author of a general treatise on entomology and of many special papers on the biology of insects, including several economic species.

Mr. J. A. Hyslop of the Bureau of Entomology has been placed in charge of the new Insect Pest Survey which is being conducted by the Bureau of Entomology in response to resolutions adopted at the Chicago meeting of the American Association of Economic Entomologists. As the Bureau has no appropriation for this work, the data must be collected largely from the State entomological agencies, and 48 entomologists have accepted their appointment as insect pest reporters for this work. A summary of these reports will be issued each month. The first regular bulletin appeared May 1, and several special bulletins have been issued.

Recent appointments to the Bureau of Entomology have been announced as follows:- Herbert D. Smith, Massachusetts Agricultural College, Scientific Assistant, Hessian Fly work, Carlisle, Pa.; E. L. Sechrist, bee culture investigations, Washington; R. W. Kelley, formerly of the Bureau and later in charge of the Insecticide and Fungicide Laboratory at Vienna, Va., fruit insect investigations on Japanese beetle work, Riverton, N. J.; Luther Brown, quarantine and regulatory work, Mexican bean beetle; L. L. English, field experiments, Mexican bean beetle; Dr. W. E. Hinds, Alabama Experiment Station, Collaborator, Mexican bean beetle; W. J. Nolan, Apicultural Assistant; Wallace E. Haley, sugar cane insect laboratory, New Orleans, La.; Theodore Henry Frison, University of Illinois, Japanese beetle project, Riverton, N. J.; C. E. Johnson, apple insect investigations, Bentonville, Ark.; C. H. Brannon, Mississippi Agricultural College, plum curculio control, Fort Valley, Ga.; Stewart Lockwood, specialist in Orthoptera for Federal work in controlling grasshoppers in the northwestern states, Fargo, N. D.

Transfers U. S. Bureau of Entomology; W. R. Smith and R. C. Gaines, Federal Horticultural Board to boll weevil force, Tallulah, La.

Mr. H. H. Thomas has been appointed temporary junior assistant, Division of Forest Insects, Entomologicial Branch, Canadian Department of Agriculture.

Mr. C. O. Eddy, a graduate of the Ohio State University, has been appointed instructor in Zoology and Entomology, North Carolina State College.

Mr. Eric Hearle of the Entomological Branch, Canadian Department of Agriculture, who is engaged in mosquito work, was married, April 9, to Miss I. B. Webb, of Hatzic, B. C.

Dr. Philip Garman of the Connecticut Agricultural Experiment Station was operated upon for appendicitis at Grace Hospital, New Haven, Conn., on May 15. At last accounts he was getting along nicely.

Mr. J. E. Eckert, Ohio State University 1916 and 1917, has been appointed Assistant Professor of Zoology and Entomology, North Carolina State College and will devote most of his time to apiculture.

Dr. W. D. Hunter and Mr. B. R. Coad of the Bureau of Entomology spent the greater part of April in the Laguna district of Mexico, in connection with the pink bollworm problem.

Prof. Z. P. Metcalf of the North Carolina State College and Experiment Station will have charge of the courses in elementary and advanced entomology at the University of Michigan Biological Laboratory, Douglas Lake, this summer.

Dr. A. W. Morrill, Consulting Entomologist, of Los Angeles, Calif., spent a month on the west coast of Mexico during the past spring investigating pests of cotton and miscellaneous crops for several of his clients. He is now planning to locate an assistant in Sinaloa under contract for continuing certain investigations and for acting in an advisory capacity to American and Mexican land owning corporations and growers organizations.

Dr. H. B. Hungerford of the University of Kansas will spend the summer at the University of Minnesota where he will be a member of the Entomological staff. He will give a summer school course in Economic Entomology and will continue his studies upon Aquatic Hemiptera.

Dr. W. E. Hinds of Alabama was elected Chairman, and Professor A. F. Conradi, of South Carolina, Secretary, of the Association of Cotton States Entomologists, at the 22nd annual Convention of Southern Agricultural Workers, held at Lexington, Ky., February 15-17, 1921.

Dr. J. F. Illingworth, who, for the past four years, has been under engagement with the Queensland Government, investigating pests of sugar cane, is returning with his family to their home in Hawaii. For the present his address will be University of Hawaii, Honolulu, T. H.

According to *Gleanings in Bee Culture* the course in bee keeping at the Massachusetts Agricultural College, which was suspended several years ago on the resignation of Dr. Burton N. Gates, is to be reinstated under Mr. Norman E. Phillips a brother of Dr. E. F. Phillips of the U. S. Bureau of Entomology.

Mr. Dwight Isely, Scientific Assistant in the United States Bureau of Entomology, has resigned and has accepted the position of Associate Professor in the Department of Entomology, University of Arkansas, and Associate Entomologist in the Experiment Station. He will devote most of his time to research work.

Dr. C. L. Metcalf, for the past seven years Professor of Entomology in Ohio State University, has resigned to accept the position of Professor of Entomology and Head of the Department of Entomology in the University of Illinois. He should be addressed in care of the University at Urbana, Illinois, after September first.

According to *Science*, Doctor Vernon Kellogg, Secretary of the National Research Council, gave three lectures on January 10, 17 and 24, on "Human Life as the Biologist Sees It" at Brown University, on the Charles K. Colver Foundation. These lectures will be published in book form by Houghton, Mifflin Company.

The Louisiana Entomological Society begins its second year with thirty-three members, including persons connected with the Louisiana State Museum, Louisiana Experiment Stations, Tulane University, Louisiana State University, U. S. Bureau of Entomology, Federal Horticultural Board, besides private collectors, beekeepers and others. Outside of Louisiana there are members in the District of Columbia, Mississippi, Kansas, Texas, and Mexico. At the February meeting, which was held at Baton Rouge, twenty-one were in attendance. The following papers were read: "Work on Malarial Mosquitoes at Mound Laboratory, Mound, La.", by D. L. Van Dine of the Bureau of Entomology; "Beekeeping in Louisiana," by E. C. Davis, of the Louisiana Experiment Stations; "Present Status of Cattle Tick Control in Louisiana," by W. H. Dalrymple, Director of the Louisiana Experiment Stations. The plan has been adopted of following the regular meeting with a "carry over" meeting to be held the day following, at which more technical matters will be discussed, the program for the next meeting will be arranged, etc.

The annual State meeting of Entomological Workers in Ohio Institutions was held at Columbus February 3, J. S. Houser, president, H. J. Speaker, vice-president and T. H. Parks, secretary.

The following papers were read:

P. R. Lowry—Economic Importance of Mealy Bugs in Ohio.

C. H. Kennedy—Notes on Dragon Flies.

E. A. Hartley—Remarks on some Aphid Parasites.

E. C. Cotton—Recent Developments of Gypsy Moth and European Corn-borer Liable to be Introduced.

W. O. Hollister—The Tree Surgeon's Knowledge of Entomology.

L. L. Huber—Remarks on a Chalcidoid Parasite.

W. V. Balduf—Life History and Habits of the Cucumber Beetle.

J. S. Houser—Control of the Cucumber Beetle.

W. M. Barrows—Insect Orientation to Heat Rays.

E. L. Chambers—Greenhouse Insect Control on a Commercial Scale.

R. C. Osburn—Next Steps in Entomological Study.

W. C. Kraatz—Notes on Aquatic Insects in Ohio.

C. L. Metcalf—The Elementary Course in Economic Entomology.

F. H. McMillen—How Entomology is Taught by the Smith-Hughes Teacher.

Ford S. Prince—Entomology's Place in County Agent Work.

H. E. Evans—The Farmer and Taxpayer's Opinion of the Application of Entomological Control Methods.

H. A. Gossard—Devices for recording the Emergence of Hessian Fly Broods.

T. H. Parks—Some Remarks on Hessian Fly and its Control.

E. W. Mendenhall—Some of the Insect Pests Found in Northeastern Ohio.

W. S. Hough—Methods Employed to Control and Eradicate the Pink Boll Worm.

E. L. Wickliff—Insect Food of Certain Ohio Fishes.

J. S. Hine—Blood-sucking Insects Observed on the Katmai Expedition.

The newly elected officers are: President, C. L. Metcalf; Vice-President, E. W. Mendenhall and Secretary, T. H. Parks.

# JOURNAL

OF

# ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Vol. 14 AUGUST, 1921 No. 4

## THE FUTURE OF BEE DISEASE CONTROL

By E. F. Phillips, *Washington, D. C.*

Discussions as to the best form of state activity in the control of the diseases of bees are frequent, and obviously not all the states are utilizing the best plan, since there is so much variation in the operations in the several states. These discussions of methods are usually for one of three purposes here given in the order of prominence in the discussions: (1) to obtain uniformity of laws and methods in order that better cooperation between the states may be brought about; (2) to obtain more efficient work in disease control; (3) to make the bee disease control work fit in with the modern trend with work which has similar objects. It seems best to review the whole subject in order to arrive, if possible, at a policy which can be uniform, efficient and modern.

To understand the problem fully it is necessary that we briefly review its history along several lines. The earliest laws usually provided for the appointment of an experienced beekeeper by the governor of the state or by some court. This is quite obviously not the best plan for it can scarcely be expected that these officials will be sufficiently conversant with the needs of beekeeping to appoint the right men to these offices. In spite of the good examples of men so appointed which may easily be offered, the plan is a poor one in principle and was poor in many cases in practice.

To remedy this defect a quiet campaign was begun some ten years or more ago to provide for different appointing power. It was obviously desirable that the appointing official shall have certain administrative functions, so that he might know that the person appointed is doing good work. The control of a brood disease requires a wide acquaintance with

the beekeeping of the state, a broad view of the subject and an ability to weigh facts in order to divide up the work judiciously. It is not a disparagement of the inspector to say that he needs supervision, for it should be obvious that the man whose work consists of the many details of the field work is almost certainly blinded to the broader aspects of the problem on which he is engaged.

When the work with bee diseases first began there were few states which had Departments to which the regulatory work in agriculture was assigned. Where such departments exist the inspection work, of course, belongs there. Even in such states, it must be admitted that the supervision given to the bee disease work has not always been efficient. Even in the poorest cases that might be cited, the work was uniformly better than that in the states where the bee inspector was a free lance.

In these states where there was then no regulatory department the more desirable plan seemed to be to place the supervision with the state entomologist, as the official most likely to have the proper regard for the work and the requisite ability to appoint the inspector and to supervise the work. At the 1907 meeting of the Association of Economic Entomologists the author[1] attempted to enlist the support of the state entomologists in this problem and he has not forgotten the kindly but emphatic way in which some of those in attendance made it clear that they did not consider it a part of their work to deal with diseases of bees. Since that time, however, there has been a change in the attitude of the state entomologists, evidenced, for example, in the keen interest manifested in the meetings of the apiculture section of the association and in the work which they have since undertaken in this field.

The earliest laws, as well as those still in operation, provide for the inspection of apiaries, either on request or at the option of the inspector- The plan of having inspection only on request has not proven efficient, as in many cases the inspector may be of service in places where he is not asked to go.

The laws further provide that where the advice or orders of the inspectors are not followed out within a reasonable time, sometimes specified in the law, the inspector is then authorized by law to destroy all infected colonies. Presumably the power thus granted is for the purpose of removing the danger of infection of other bees, but in reality it is a

[1]Phillips, E. F., 1908. Bee diseases: a problem in economic entomology. Jr. Econ. Ent. I, No. 2, pp. 102–105.

punishment for the beekeeper who does not do his duty as laid down in the law. If we, for the purpose of argument, assume that any part of such destruction is for the purpose of punishment, then the inspector becomes sole judge of the existence of disease, judge as to whether his orders have been carried out, the legal officer who brings action for prosecution and finally the marshall who carries out the provisions of the law in the way of destruction. Merely to mention these functions is sufficient to show that this is too much power to place in the hands of one man where there are property rights to be considered. In order to minimize this, it has sometimes been pointed out that a colony of bees suffering from disease has no market value and that to destroy it is not to destroy valuable property. No beekeeper really believes this argument for obviously the hives and material equipment are as good as if no disease existed, the wax in the combs may be saved and even the bees themselves may usually be saved by proper care.

In almost all cases, the laws provide that the inspector shall teach the beekeeper how to treat the disease found, and in some cases it is further provided that the inspector shall take whatever other steps shall be deemed desirable for the furtherance of beekeeping in the state. This would include other educational work and this provision of the law has been used to good advantage, even in states where no other educational work was being undertaken in beekeeping. It is obviously not the intent of most of these laws that an educational system would be built up for the furthering of beekeeping.

It is opportune that we review this subject to see in what way this inspection work has proven most helpful. Taking first European foulbrood, the control of this disease demands that the beekeeper provide those features which lead to colony prosperity in early summer so that the bees can throw off the disease. It therefore becomes necessary for the beekeeper so to provide for the deficiency of his locality that the bees may build up. It takes a better beekeeper to continue to keep bees in European foulbrood regions than is required in the average locality.

To overcome the deficiencies of a European foulbrood region requires good beekeeping and good beekeepers cannot be made by the exercise of police power. It has been shown most clearly that rigid inspection provisions and the enforcement of the provisions of the usual state laws are not of the slightest value in combating European foulbrood. The making of good beekeepers is so obviously a matter of education that it seems foolish to continue longer to try to control this disease by the enactment or enforcement of legislation.

American foulbrood may at first glance seem to be quite unlike the other serious brood diseases in that there is danger of the spread of the

disease through robbing out of colonies that have died of the disease It is evident that the careless beekeeper, or the one who desires to injure his beekeeping neighbors, can do much harm. Especially for this disease it is often recommended that rigid inspection be carried out and that those beekeepers who fail to treat the disease shall be punished as provided by law. Nothing will so insure a feeling of malice as punishment by the inspector, and it thus becomes a serious menace to the beekeeping of the region to apply the provisions of the law to those beekeepers who fail to do as ordered by the inspectors. Cases are known in which this disease has been spread intentionally, and the damage done is usually far greater than that brought about by normal spread.

The proper treatment of American foulbrood can be applied only by a beekeeper who has been taught how to treat the disease. The ignorant beekeeper often does more harm than good when he conscientiously tries to do what the law requires. The problem is therefore strictly one of education, the training of the beekeepers in the region where the disease exists how to combat it. In a few cases the inspector has felt that his duty is done when he finds the disease, marks the hives and orders a clean-up. Such work is practically valueless, and when the beekeepers of a region find that their inspector is doing that kind of work they usually ask for his prompt removal. So-called sacbrood is not sufficiently serious to need any inspection but only by education may this condition be distinguished from the other brood diseases.

The question then arises as to what should be done about the adult diseases about which there is so much discussion in the beekeeping press. The cause of none of these is known, unless perchance *Nosema apis* actually does damage; there is no rational treatment that can be recommended and the only thing that can be done is to take good care of the bees so that the troubles may disappear. There does not seem much for a police officer to do under such circumstances. There is really not much that the educator may do except to reduce the fear of the beekeeper who sees some bees die and who takes at their face value the alarming articles that appear from time to time.

The only remaining question is whether there is some disease of bees that is dangerous to the welfare of the industry and which is not widespread. If this were the case, then beekeepers might rightly ask for the quarantine of bees from that area. So far as we are able to judge, European foulbrood is now present in practically every locality where it can do damage, and even where it is present it is doing little harm to the good progressive beekeepers. American foulbrood is present in almost all parts of the United States, certainly present in every state where

there is any probability of beekeeping being a large industry. It would be a serious thing to have quarantines established or legalized further than they are now for the quarantine powers have already been abused, as is the keeping out of competing honey from certain markets under the guise of disease control. In no case that has come to the attention of the author has a quarantine been of any real value to the beekeeping industry.

Not only has police power not been extensively used, but the very existence of the power has been recognized as a handicap to the work. This is illustrated by the fact that Iowa has seen fit to call the official who corresponds to the apiary inspector by the name "State Apiarist". Pennsylvania has an "Apiary Adviser" and other states have in the same manner tried to hide the power granted to these men. That police power is a handicap is further shown by the fact that it has long been widely recognized that the county system of inspection is a failure. The trouble is that a beekeeper can not go to a neighbor beekeeper and get him to clean up the disease that may be present without engendering the thought that the work is done so that the region may be made better for the inspector or that the bees of the region may actually be killed off for his benefit. Were it not for the existence of the police powers of the inspector, a local man might efficiently serve, for there would not be the same feeling against an avowed educator.

The exercise of general police powers is dangerous to the beekeeping industry, yet there may be cases where a show of power may be helpful. In order that such hypothetical cases may be covered, the new Iowa law provides that in case the state apiarist shall find neglected disease he may report the case to the local officials charged with the enforcement of the other laws of the state and county and these local officials shall then take charge of the case. In New York, where inspection has been carried on since 1899, there have been few occasions where an exercise of police powers seemed wise. If the beekeepers still wish the power to be retained the law may be modified as in Iowa. In states where there is a department of the state government which has charge of the regulatory laws of agriculture, this power should be put in the hands of that department.

It seems that the beekeeping industry has been able to obtain the services of a competent lot of teachers of beekeeping throughout the country under the guise of having inspection for the prevention of the spread of the diseases of bees. That the work has been of the greatest good to the beekeeping industry is beyond question to any one familiar

with the details of the work,[2] and it is impossible to overestimate the value of this effort. It may seem somewhat strange that so great good has come from this work when it must be admitted that the inspectors have not done the things that are provided by the law.

At the time that the first of these laws were passed it would have been folly to go to a state legislature and ask for money for the education of the beekeepers of the state. The legislators were, however, willing to provide funds for the eradication of the diseases which were and still are causing trouble to the beekeepers, and in almost all cases the work once begun has been continued. The inspectors found the beekeepers ignorant of the diseases, not willfully negligent, and they soon saw that the right way to get these diseases under control was to teach the beekeepers how to care for their bees so that the diseases would do little harm. They further saw that many beekeepers were not practicing the right methods in other phases of their beekeeping work, and it was natural that a man good enough to be chosen as an inspector should be willing and glad to help his fellow beekeepers in every way possible. There soon grew up a system for the education of the beekeepers of the states. The defects that appeared, and which it was tried to overcome, in the way of appointment and supervision, were incident to education rather than to police inspection.

The work now so well known under the name "Extension" was begun but a few years ago and this educational work has proven so useful that it is now nation-wide. With the passage of the Smith-Lever Law this work was made a matter for cooperative action between the Federal Department of Agriculture and the Extension Divisions of the agricultural colleges of the several states established for the purpose. With the spread of this work, the value of an attack against poor agriculture by means of education became evident and it is no longer necessary to argue for it. Educational work of a similar character had long been done in many lines of agriculture, but very little has been done for beekeeping by the agricultural colleges. Beekeeping had its "extension men" however in many of the states, these men working under the apiary inspection laws. Extension work in beekeeping thus anticipated the general work in agricultural extension by several years.

In 1916 the Bureau of Entomology began extension work in beekeeping in cooperation with the extension divisions of several states and this work was advanced rather rapidly because of the war. The work is

[2]Phillips, E. F., 1916. The results of apiary inspection. Read at Apiculture Section Meeting, Assn. Econ. Ent. New York: Jr. Econ. Ent. 1917.

well under way and is in great demand, not only from beekeepers but from the extension divisions. This work differs somewhat in character from that done by the inspectors in that in addition to the emphasis placed on disease control an effort is made to remedy the defects of beekeeping practice as they are seen from a nation-wide view of the beekeeping industry. It is work of the same type, usually being done by beekeepers better prepared for educational work than are the inspectors.

If we are to have any changes in these state laws, therefore, they should be along the lines previously indicated and the new laws should contain the following provisions:

(1) An elimination of the police powers of the persons appointed under the law.

(2) The placing of this work under the supervision of the extension division of the agricultural colleges of the several states.

(3) The placing of whatever regulatory measures are deemed necessary with the regulatory offices of the state, entirely apart from the agricultural colleges.

(4) A retention of the interest of the entomologists who have taken so active a part in the development of the present educational system as state leaders in this work, in order that they may still continue to supervise it.

This policy will eliminate politics, provide adequate and necessary supervision, bring about uniformity, automatically insure cooperation among the several states as is not now possible, and, finally most essential, it will get results.

In presenting this problem for consideration, the author is advocating nothing new but is attempting merely to outline the present tendency in this work in order that those interested may more efficiently ask for what they want. The recommendations concerning state laws which the author has made in the past are essentially in harmony with the plan here outlined and recommended. The actual methods of inspection advocated are harmonious with the educational aspect of the work however useless certain provisions of suggested laws may have been. The changes that have occurred in the apiary inspection work are those which must arise from the very nature of the problem that has confronted us and the movement herein outlined is an inevitable one. A clear recognition of this fact will prevent attempts to retard the work by the introduction of methods and ideas antagonistic to the evolutionary trend and antagonistic to the best interests of the beekeeping industry.

# LATE FEEDING LARVAE INJURIOUS TO APPLE IN PENNSYLVANIA INCLUDING SEVERAL NEW INJURIOUS SPECIES

By S. W. Frost, *State College, Pa.*

One of the most serious problems confronting the Fruit growers of Pennsylvania is the control of various late feeding Lepidopterous larvae which mar the fruit of Apple. As maturity advances each year quantities of marketable fruit are seriously lessened by them. Many of the species gnaw large cavities into the sides of the fruit, making them worthless, a few burrow within the apples, while others produce small scars or blemishes on the surface. The last mentioned type, although often small in size, detract largely from the quality of the fruit and prevent them from being packed and sold as first class apples. This results in a lower percentage of marketable fancy fruit and consequently a tremendous loss in returns to the orchardist. A further loss is incurred by the large proportion of fruit which drop in spring as a result of the early attacks of leaf-rollers and other feeders.

From our studies of the habits of Lepidopterous larvae injurious to apple, it appears that some workers have been misled concerning the types of injuries and the species causing them. This may be because the field has not been carefully investigated. Few workers have studied the types of injuries of apples or correlated them with the work of particular larvae. Some isolated species or groups of species have been studied more or less in detail. Among these, Mr. Slingerland's paper on "Green Fruit Worms", is the most notable. Among those of more recent date is a paper by Fulton on "Insects injurious to Apple Fruit", in which some phases of the scarring of apple fruit have been discussed.

The work of the past deals chiefly with the early feeders of apple, leaving the field of late feeders almost untouched. Leaf-rollers, for example, have long been considered as most injurious early in the season. In referring to injuries produced by this group, most writers lay emphasis on the injury caused by the larvae webbing the leaves and fruit together and the cavities produced in the sides of the fruit while they feed from within these shelters. On the other hand little attention has been directed to the late feeding of Leaf-rollers or Bud-moths. Fulton (1918) mentions them very briefly. In our investigations the late feeders are an important factor and it has been found that over

fifty per cent of the leaf-roller injury to picked fruit are of the late type. The majority of these injuries occur two or three weeks prior to picking time. The larvae have been found abundant and feeding voraciously at picking time.

These late feeding larvae have not, in the past, been generally considered as a class by themselves. In Pennsylvania they form an important and conspicuous group containing many injurious species whose seasonal activities overlap to some extent with the early feeders. The Bud-moths, for example, feed early in the spring as well as late in the fall. The same is true of the Leaf-rollers. We have found, however, that although the species overlap, the types of injuries are distinct. The scars produced early in the summer heal over and at picking time appear as russety spots or cavities. The late injuries, however, remain fresh and do not become russety or even calloused.

The late feeding larvae may be divided into three general classes, namely; the Leaf-rollers, Bud-moths and Codlin moth together with other similar feeders. The former produce large and sometimes deep cavities while the second class usually make small cavities or blemishes on the surface. The Codlin moth, as is well known, may cause side injury or burrow into the center of the fruit. A particular type of injury frequently spoken of as "Pin-Hole Injury" may be caused by Bud-moths, Case bearers or other small feeders.

The research thus far carried on has revealed many of the species responsible for the late summer injuries to the fruit of apples. Among the Leaf roller group which have been found in Southern Pennsylvania, can be named the Oblique Banded Leaf-roller (*Archips rosaceana* Harris), a new injurious species, the Red Banded Leaf-roller (*Eulia velutinana* Walk.) and another new apple pest (*Amorbia humerosana* Clem.) The Oblique Banded Leaf roller is neither abundant nor a serious pest with us. The Fruit Tree Leaf-roller has not been found in the Southern part of the State. On the other hand the Red Banded Leaf-roller (*Eulia velutinana* Walk.) is exceedingly abundant and injurious and causes most of the late injury noticed in our region. The larva of this species is entirely green in color and resembles (*Eulia quadrifasciana* Fernald), which has been reported from apples in New York State. A recent survey of the State of Pennsylvania reveals the fact that *Stenoma algidella* Walk. is common and widely distributed.

There are two Bud-moths which are responsible for the late scars and blemishes produced on the fruit, The Eye spotted Bud-moth (*Tmetocera ocellana* Schiff) and a new injurious species, *Sparganothis idae-*

*usalis* Walk. Both species are abundant and injurious. *Sparganothis* resembles somewhat the common Bud-moth in size and in having a shiny black head and prothorax, but the body is olive in color.

Among the smaller late side feeders of apple may be mentioned the Codlin moth (*Carpocapsa pomonella* Clem.), the lesser apple worm (*Laspeyresia prunivora* Walsh) and the Lesser Bud-moth (*Recurvaria nanella* Hubner). Neither of the last two species have been found very abundant. *Recurvaria nanella* is, however, the more common and considering the many localities from which it has been reported in the Eastern States, it seems that this may be a more serious pest in parts of the country than the Lesser apple worm.

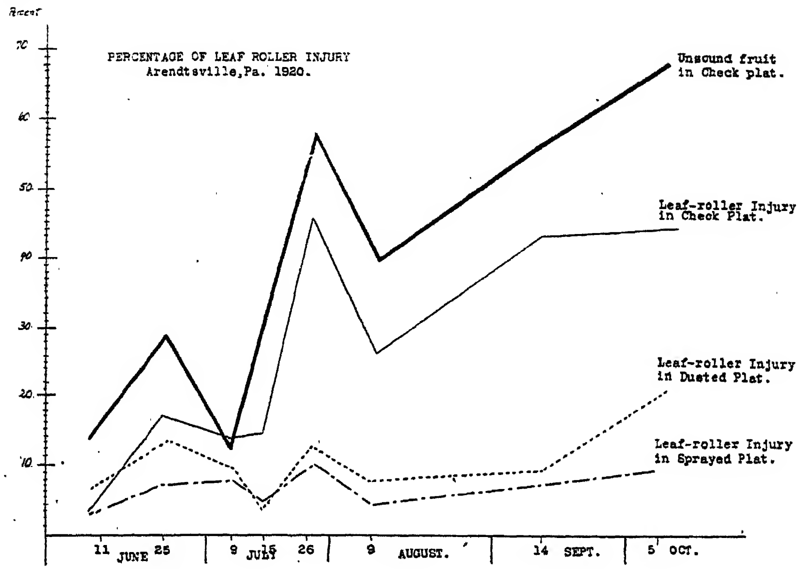
In making this hasty review of the situation as regards late feeders, it is hoped that we have been able to clear up considerable of the confusion existing both in literature and in the minds of many investigators of Fruit insects. Not only have the injuries been confused in the past but a lack of definite knowledge of the species of insect or their habits has made their control difficult. The discovery of the preceeding new injurious species and their late feeding habits has helped considerably to clear up the situation but there is still much work to be done.

Control measures against these species take into consideration spraying to poison the early spring broods of the various species. Our tests indicated that arsenate of lead in the dormant and delayed dormant sprays is important. We have been able to secure a much larger percentage of control in plots where both of these applications were included in the spraying program. Comparisons have been made with dust applications similarly applied, but as indicated in the accompanying diagrams, the liquid sprays have proven thus far the most satisfactory. The experiments clearly demonstrate that injuries from these late summer feeding lepidopterons can be materially reduced if orchardists practice consistent and thorough spraying during the early spring months.

## Explanation Of Charts

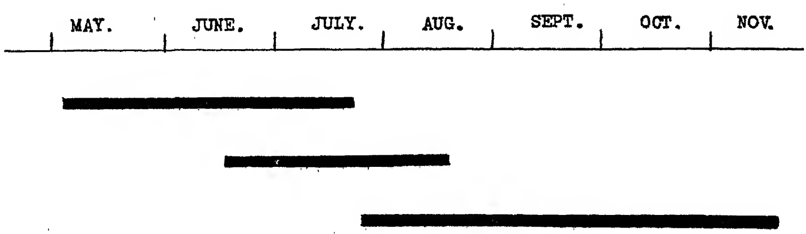
The following chart illustrating the percentage of Leaf roller injury was prepared from the examination of 29,482 drop fruits, approximately 10,000 fruits from each, the Check, Dusted and Sprayed plats. These were gathered throughout the summer from June 11th. to October 5th, as indicated on the horizontal axis. The curve for Leaf roller Injury unquestionably molds the curve for percentages of Unsound Fruit.

The latter curve is not absolutely comparable with the other curves because it represents the percentage of fruits while the other curves are the percentages of injuries. Hence we find that the curve for un-




sound fruit drops below the curve for Leaf-roller Injury in the Check on July 9th. The three high points of the Leaf-roller curve are indicative of the three generations of the Leaf-roller, *Eulia velutinana* Walk.,

CHART ILLUSTRATING THE NUMBER AND OVERLAPPING OF GENERATIONS OF *Eulia velutinana* Walk.




which caused the injury and is shown on the chart illustrating the number and overlapping of generations of this species. The curves for the Sprayed and Dusted plats indicate a considerable reduction in per-

centage of injury by Leaf-rollers in favor of the spray.[1] It will be further noticed that, in the check, the Leaf-roller injury reached it's climax late in the season.

The chart illustrating the Number of Generations was secured from larvae reared in confinement and checked with orchard conditions. The first two generations were reared through completely but the last generation was calculated from eggs laid towards the end of July. At this time and during the first of August newly hatched larvae were found abundant in the orchards.

## STUDIES OF SANNINOIDEA OPALESCENS EDW. IN OREGON

By Frank H. Lathrop, and A. B. Black, *Oregon Agricultural College Experiment Station, Corvallis*

In 1916 the Oregon Station undertook an investigation of the Western Peach and Prune Root Borer, *Sanninoidea opalescens* Edw. with Mr. G. F. Moznette in direct charge of the work. Upon the resignation of Mr. Moznette in 1917, the project was taken over by the senior author, who was later joined by the junior author in the prosecution of the work.

The formulation of an effective and economical means of control has been the primary object of the investigation. Life history studies have been conducted as a minor part of the work.

### Life History Studies

Winter Conditions. Overwintering larvae seem to be active during warm periods and it is probable that some growth takes place during this season. Our observations show that during periods of cold rainy weather the larvae tend to leave their tunnels and work in the gum and frass as well as the soil immediately surrounding the tree. Many of these larvae lie dormant in silken cells which they spin against the tree trunk beneath the soil surface.

The winter cell is constructed with one side against the bark of the tree. In shape it is oval. The outer wall consists of a very thin silken membrane, concavo-convex in form, forming a cell in which the lar-

[1]Six applications were made both to the sprayed and Dusted plats. A 90-10 Dust was used with the addititon of 1% Nicotine, as Nicotine sulphate. On the sprayed plats Lime Sulphur and Arsenate of Lead was used with the addition of Black Leaf 40 in the first four sprays.

va lies curled. The cell varies in size with the age of the larva which constructs it. We have found these cells ranging in width from five to twenty millimeters, and in length from eleven to twenty-five millmeters.

This habit of constructing winter cells seems to be much more pronounced in heavy, wet soils, than in more porous types.

SPRING ACTIVITIES. With the approach of spring the larvae become more active. Those which wintered in cells outside the trees resume their places in the tunnels under the bark. The more mature larvae soon spin cocoons in preparation for pupation. Cocoons were found at Roseburg as early as April 22, but were not found in great numbers until late May or early June. At Corvallis and the more northern portions of the State, these activities are more delayed.

ADULTS: EMERGENCE, FEEDING, OVIPOSITION. During several years of field observation at Corvallis we have found that moths begin to emerge during the last week of June. The number of adults emerging increases until late July. The last week in July shows a decline in the numbers emerging. Living pupae have been collected in the field at Corvallis as late as August 12.

At Roseburg in 1919 moths began to emerge as early as June 18. July marked the period of maximum emergence. Moths emerged as late as August 15 from cocoons which had been placed in breeding cages.

We found that captive moths took readily—almost greedily—distilled water, and also a dilute sugar solution. In the case of females such feeding seemed to stimulate oviposition. No attempts were made to attract moths to bait solutions in the field.

We have found that oviposition ordinarily takes place soon after emergence. In the field, eggs are most frequently placed on the trunk of the tree, but occasionally on the larger limbs. In a few instances, females were observed to deposit eggs on the soil at the base of the tree. Specimens in small cages show much less selection and the eggs are deposited, on any part of the tree, including the leaves, and even on the wire and cloth of the cage.

Records were kept of the number of eggs deposited by females confined in small cages. Upon the death of each moth the body was dissected and the number of unlaid eggs also recorded.

The results are shown in the following table:

TABLE I

| Eggs | Moth Number 1 | 2 | 3 | 4 | 5 | 6 | 7 | Average |
|---|---|---|---|---|---|---|---|---|
| Deposited | 183 | 506 | 159 | 279 | 136 | 105 | 125 | 213.3 |
| Dissected out | 427 | 14 | 336 | 278 | 533 | 523 | 708 | 402.7 |
| Total | 610 | 520 | 495 | 557 | 669 | 628 | 833 | 616.0 |

LARVAL ACTIVITY. Upon hatching from the egg the young larva immediately attempts to bore its way into the bark of the tree. If it succeeds, a tiny pile of frass marks the point of entrance. The young larva spends a considerable part of its life tunneling in the corticular region of the bark. During this period it may travel a considerable distance, and it leaves behind a tortuous trail of darkened tissues just beneath the surface of the outer bark. We cannot say what is the length of time which the larva spends in this way, but we have found in these superficial burrows larvae ranging from newly hatched to fifteen millimeters in length.

Apparently upon reaching a length of fifteen or twenty millimeters the larva proceeds to form its typical tunnel in the cambium beneath the bark, which constitutes the characteristic injury so well known to peach and prune growers. These tunnels are linear in form, usually fairly straight, and extend vertically with the grain of the wood; although irregular, side tunnels are not infrequently found. We have found tunnels of this type as small as thirty two by seven millimeters. The complete tunnels usually vary in width from fifteen to thirty millimeters or more, and extend vertically to a length of one hundred to one hundred fifty millimeters or more. The most common location of these tunnels is at the crown of the tree; the upper extremity of the tunnel ordinarily extending some thirty millimeters above the soil surface, the lower extremity reaching some distance below the soil surface. We have frequently observed a round hole, approximately seven millimeters in diameter connecting the complete tunnel with the exterior just at the surface of the soil. This opening is not invariably present however, and many burrows are to be found without any apparent communication with the exterior.

The presence of larvae is not limited to the crown of the tree. Especially on rough bark trees larvae may be found working on the trunk and in the crotches. This species seems to show a greater tendency in this respect than does the Peach Tree Borer of the East, *Sanninoidea exitiosa* Say.

## Experiments In Control

Our observations of the winter habits of the root borer larvae, led us to investigate the possibility of applying some substance during fall or winter which would destroy the larvae in their winter cells and possibly those which remained in the superficial burrows. A series of tests were applied as follows:

| | | | | | |
|---|---|---|---|---|---|
| Plot 1. | Scalecide | 1 pt. | Plot 5. | Nicotine Resinate | 3 ozs. |
| | Water | 7 qts. | | Water | 7 qts. |
| Plot 2. | Scalecide | 1 pt. | Plot 6. | Check. No treatment | |
| | Sodium Arsenate | 2 ozs. | | | |
| | Water | 7 qts. | | | |
| Plot 3. | Scalecide | 1 pt. | Plot 7. | Fuller's Earth[1] | 5 lbs. |
| | Nicotine Sulfate 40% | 3 ozs. | | Nicotine Sulfate 40% | ¼ lb. |
| | Water | 7 qts. | | | |
| Plot 4. | Nicotine Oleate | 5 ozs. | Plot 8. | Sulfur dust | 5 prts |
| | Water | 7 qts. | | Lead arsenate (powder) | 1 pt. |
| | | | | Tobacco dust | 4 prts. |

The soil was removed from the base of each tree to the depth of four to six inches. A generous amount of the liquid or dust was then applied and the soil replaced about the tree.

In no case was there a satisfactory control, and these substances do not seem promising. This failure does not necessarily indicate that treatment at this time is inapplicable, but some more satisfactory larvicide must be found before the treatment will be effective.

## Miscible Oil - Sodium Arsenate Sprays

The fact that the young larvae spend a considerable period in the outer bark led us to hope that by using a soluble arsenate with miscible oil as a carrier, the corticular region of the bark might be so thoroughly saturated with poison as to kill the larvae as they worked in this region.

For this purpose the following formula was used.

| | |
|---|---|
| [1]Miscible Oil No. 1. | 1 pint. |
| Sodium arsenate | 2 ounces |
| Water to make two gallons | |

[1]A commercial spray oil prepared by General Chemical Co., San Francisco, Cal.

This solution was applied by means of a small compressed air hand sprayer. A bordeaux nozzle was used, adjusted to throw a solid stream of considerable force. The solution was applied to the bases of the trees, from the soil surface to a height of approximately eighteen inches and some of the solution was puddled about the base of the tree. The following tables show the series of applications made, and the results.

TABLE II - SODIUM ARSENATE - MISCIBLE OIL APPLICATIONS
State Hospital Farm, Salem, Oregon, 1920

| Treatments | | | | Results | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Row No. | No. of applications | Dates of applications | Trees treated | Trees wormed | Date wormed | Trees Infested No. | Trees Infested % | Number of Worms Total | Number of Worms average per tree |
| D1 | 5 | July 1, July 21, Aug. 26, Sept. 15, Sept. 30 | 16 | 5 | Oct. 14 1920 | 4 | 80 | 10 | 2 |
| D2 | 3 | July 21, Aug. 26, Sept. 15 | 16 | 5 | " | 4 | 80 | 6 | 1.2 |
| D3 | 2 | Aug. 26, Sept. 15 | 16 | 5 | " | 3 | 60 | 4 | 0.8 |
| D4 | 2 | Sept. 15, Oct. 9 | 16 | 5 | " | 5 | 100 | 16 | 3.2 |
| D5 | 1 | Oct. 9 | 15 | 5 | " | 3 | 60 | 9 | 1.8 |
| D6 | 3 | July 1, Aug. 26, Oct. 9 | 16 | 5 | " | 3 | 60 | 5 | 1.0 |
| C1 | 0 | Check no treatment | 0 | 5 | " | 4 | 80 | 25 | 5.0 |
| C2 | 0 | Check no treatment | 0 | 5 | " | 5 | 100 | 13 | 2.6 |
| C3 | 0 | Check no treatment | 0 | 5 | " | 4 | 80 | 8 | 1.6 |

TABLE III - SODIUM ARSENATE - MISCIBLE OIL APPLICATIONS
Busenbark Orchard, Roseburg, Oregon, 1920

| Treatments | | | | Results | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Row No. | No. of applications | Dates of applications | Trees treated | Trees wormed | Date wormed | Trees Infested No. | Trees Infested % | Number of worms Total | Number of worms average per tree |
| D1 | 4 | June 28, July 16, Aug. 11, Sept. 4 | 20 | 5 | Oct. 24 1920 | 2 | 40 | 2 | 0.4 |
| D6 | 2 | June 28, Aug. 11 | 20 | 5 | " | 1 | 20 | 1 | 0.2 |
| 49 | 0 | Check no treatment | 0 | 5 | " | 3 | 60 | 5 | 1.0 |

These results show that the treatment has failed to reduce infestation to a satisfactory extent.

## Tree Washes

During the summer of 1920 rather extensive tests were made of white-wash and of Fuller's Earth wash containing various active agents, such as arsenate of lead, nicotine sulphate, naphthalene, etc. In applying all of these washes, the soil was removed from the base of the tree to the depth of about four inches. The trees were allowed to stand thus until next day, when the adhering soil particles were removed by means of a stiff brush. The wash was then applied as a paint by means of a white-wash brush, the trunks being coated to a height of fourteen to sixteen inches.

The formulas used were as follows:

### Whitewash

Row A1. Quick lime 8 lbs.
Arsenate of lead (pd.) ¼ lb.
Salt 2 lbs.
Glue ¼ lb.
Nicotine Sulfate 40% 2 ozs.
Water to make thick paint.

Row A4. Quick lime 8 lbs.
Arsenate of lead (pd.) ¼ lb.
Salt 2 lbs.
Glue ¼ lb.
Water to make thick paint.

Row A2. Similar to A1 with the addition of one pound of copper sulfate.

Row A3. Quick lime 8 lbs.
Salt 2 lbs.
Glue ¼ lb.
Naphthalene (flake) 12 ozs.
Water to make thick paint.

Row A5. Quick lime 8 lbs.
Salt 2 lbs.
Glue ¼ lb.
Nicotine sulfate 40% 2 ozs.
Water to make thick paint.

Table IV - Whitewash Treatments, State Hospital Orchard
Cottage Farm, Salem, 1920

| Treatments | | | | | Results | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Row No. | No. of applications | Dates of Applications | Number of Trees Treated | Number of Trees Wormed | Date Trees Wormed | Trees Infested Number | Trees Infested Percent | No. of Worms Total | No. of Worms Average per tree |
| A1 | 2 | July 2 Aug 26 | 17 | 5 | Oct 13 | 4 | 80 | 8 | 1.6 |
| A2 | 2 | July 2 Aug 26 | 20 | 5 | Oct 13 | 3 | 60 | 9 | 1.8 |
| A3 | 2 | July 2 Aug 26 | 13 | 10 | Oct 13 | 2 | 20 | 3 | 0.3 |
| A4 | 2 | July 2 Aug 26 | 20 | 5 | Oct 13 | 5 | 100 | 7 | 1.4 |
| A5 | 2 | July 2 Aug 26 | 20 | 5 | Oct 13 | 4 | 80 | 10 | 2.0 |
| C5 | 0 | Check | 0 | 5 | Oct 13 | 5 | 100 | 16 | 3.2 |
| C6 | 0 | Check | 0 | 5 | Oct 13 | 5 | 100 | 22 | 4.4 |
| C7 | 0 | Check | 0 | 5 | Oct 13 | 5 | 100 | 19 | 3.8 |

TABLE V - WHITEWASH TREATMENT, BUSENBARK ORCHARD
Roseburg. 1920

| Treatments | | | | | | Results | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row No. | No. of applications | Dates of Applications | Number of Trees Treated | Number of Trees Wormed | Date Trees Wormed | Trees Infested Number | Trees Infested Percent | No. of Worms Total | No. of Worms Average per tree |
| A1 | 2 | June 28 Aug 11 | 20 | 5 | Oct 24 | 3 | 60 | 6[1] | 1.2 |
| A2 | 2 | June 28 Aug 11 | 20 | 5 | Oct 23 | 3 | 60 | 6 | 1.2 |
| A3 | 2 | June 28 Aug 11 | 20 | 10 | Oct 23 | 0 | 0 | 0 | .0 |
| A4 | 2 | June 28 Aug 11 | 20 | 5 | Oct 24 | 4 | 80 | 7 | 1.4 |
| A5 | 2 | June 28 Aug 11 | 20 | 5 | Oct 24 | 0 | 0 | 0 | .0 |
| C17 | 0 | Check | 0 | 5 | Oct 24 | 4 | 80 | 20 | 4.0 |
| C21 | 0 | Check | 0 | 10 | Oct 24 | 8 | 80 | 34 | 3.4 |
| C24 | 0 | Check | 0 | 5 | Oct 24 | 4 | 80 | 16 | 3.2 |

A study of tables IV and V will show that in general there was a distinct reduction of infestation in the whitewashed trees, although in some cases this is not much greater than may be accounted for by chance irregularity in distribution of infestation.

The rows (A3) treated with the wash containing naphthalene show up to best advantage. In the ten trees examined at Salem only two trees were found to be infested, and these harbored a total of only three larvae. The trees at Roseburg show up even better, and in the ten trees examined no infestation was found.

## FULLER'S EARTH-MOLASSES WASH

In the course of our work a series of experiments was performed in an effort to develop a wash which would be more suitable than white wash as an application to the bases of the trees for root borer control. After preparing some forty different mixtures, we succeeded in preparing a wash which seemed to fulfil most of the requirements quite well. The wash is composed primarily of Fuller's Earth, molasses, and glue. This forms a very hard coating which is quite resistant to weather conditions, and shows a minimum of cracking.

The Fuller's Earth washes were applied in a series quite closely parallel with the whitewash series, as shown by the following formulas:

[1]One larva found in trunk above area of whitewash was not included in this table.

B1. Fuller's Earth 8 lbs.
Molasses (stock food) 4 pts.
Glue (granulated) 1¼ lbs.
Arsenate of lead 1 lb.
Nicotine Sulfate 40% 4 ozs.
Water to make thick paint.

B2. Similar to wash B1 with the addition of 1 pound of Copper Sulfate.

B3. Fuller's Earth 8 lbs.
Molasses (stock food) 4 pts.
Glue (granulated) 1¼ lbs.
Naphthalene (flake) 12 ozs.
Water to make thick paint.

B4. Fuller's Earth 8 lbs.
Molasses (stock food) 4 pts.
Glue (granulated) 1¼ lbs.
Derris (powdered) 1 lb.
Water to make thick paint.

B5. Fuller's Earth 8 lbs.
Molasses (stock food) 4 pts.
Glue (granulated) 1¼ lbs.
Arsenate of lead 1 lb.
Water to make thick paint.

B6. Fuller's Earth 8 lbs.
Molasses (stock food) 4 pts.
Glue (granulated) 1¼ lbs.
Nicotine Sulfate 40% 4 ozs.
Water to make thick paint.

B7. Quick lime 5 lbs.
Molasses (stock food) 4 pts.
Glue (granulated) 1¼ lbs.
Arsenate of lead 1 lb.
Nicotine Sulfate 40% 4 ozs.
Water to make thick paint.

TABLE VI - FULLER'S EARTH WASHES, STATE HOSPITAL ORCHARD
Cottage Farm, Salem, 1920

| Treatments | | | | | Results | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Row No. | No. of Applications | Dates of Applications | No. of Trees Treated | No. of Trees Wormed | Date Trees Wormed | Trees Infested No. | Trees Infested per cent | No. of Worms Total | No. of Worms Average per tree |
| B1 | 2 | July 2 Aug 26 | 19 | 5 | Oct. 13 | 3 | 60 | 6 | 1.2 |
| B2 | 2 | July 2 Aug 26 | 20 | 5 | Oct. 13 | 2 | 40 | 4 | 0.8 |
| B3 | 2 | July 2 Aug 26 | 19 | 10 | Oct. 13 | 2 | 20 | 3 | 0.3 |
| B7 | 2 | July 2 Aug 26 | 20 | 5 | Oct. 13 | 2 | 40 | 4 | 0.8 |
| C7 | 0 | Check | 0 | 5 | Oct. 13 | 5 | 100 | 19 | 3.8 |
| C8 | 0 | Check | 0 | 10 | Oct. 13 | 9 | 90 | 31 | 3.1 |

TABLE VII - FULLER'S EARTH WASHES, BUSENBARK ORCHARD
Roseburg, 1920

| Treatments | | | | | Results | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Row No. | No. of Applications | Dates of Applications | No. of Trees Treated | No. of Trees Wormed | Date Trees Wormed | Trees Infested No. | Trees Infested per cent | No. of Worms Total | No. of Worms Average per tree |
| B1 | 2 | June 28 Aug 11 | 19 | 5 | Oct. 24 | 1 | 20 | 3 | 0.6 |
| B2 | 2 | June 28 Aug 11 | 20 | 5 | Oct. 24 | 1 | 20 | 1 | 0.2 |
| B3 | 2 | June 28 Aug 11 | 20 | 10 | Oct. 23 | 1 | 10 | 1 | 0.1 |
| B4 | 2 | June 28 Aug 11 | 20 | 5 | Oct. 24 | 1 | 20 | 2 | 0.4 |
| B5 | 2 | June 28 Aug 11 | 19 | 5 | Oct. 24 | 2 | 40 | 3 | 0.6 |
| B6 | 2 | June 28 Aug 11 | 20 | 5 | Oct. 24 | 4 | 80 | 12 | 2.4 |
| B7 | 2 | June 28 Aug 11 | 20 | 5 | Oct. 24 | 3 | 60 | 10 | 2.0 |
| C12 | 0 | Check | 0 | 10 | Oct. 23 | 8 | 80 | 19 | 1.9 |
| C17 | 0 | Check | 0 | 5 | Oct. 24 | 4 | 80 | 17 | 3.4 |

An examination of tables VI and VII shows that the Fuller's Earth washes have some superiority over the lime washes. This superiority may be more pronounced in sections having considerable summer pre-

cipitation than it is in Oregon where there is very little rain during the summer months. Here again the washes containing naphthalene show up to best advantage, and have given a satisfactory control.

This uniformity of results from the use of the naphthalene washes is especially pleasing, and we believe warrants further tests of this material. We would be greatly interested in having other workers on this problem test the use of naphthalene as an active agent in washes for the control of either the Eastern or Western Root Borer.

## PARASITISM AND NICOTINE IN THE CONTROL OF THE ORIENTAL PEACH MOTH: A SECOND REPORT

By LOUIS A. STEARNS, *Associate Entomologist, Virginia State Crop Pest Commission*

In respect to its distribution in Virginia, the status of the oriental peach moth, at the present time, remains unchanged. The Virginia infestation is still a well defined area within a few miles of Washington city. Here, however, there are indications of the increasing destructiveness of the species.

Collections have shown that within three years the numbers of the insect have been practically doubled. It has established itself with surprising rapidity in isolated plantings of young peach. That the pest has not spread by natural means to the important fruit-growing district of extreme northern Virginia is due possibly to a strip of forested and farming land some thirty miles in width intervening.

The lowest record, in 1920, of average infestation in small home-garden plantings of two-year old peach, based on twig counts, was 37 per cent, while in the case of individual trees, the injury ran as high as 81 per cent. In one instance, injury in a block of budded peach stock was found to exceed 85 per cent of all terminals.

A study made in an established orchard of the comparative growth of 600 uninfested and infested peach twigs of trees distributed among the varieties Belle, Bilyeu, Carmen, Elberta, Heath, Hiley, Salway and Smock produced interesting data. These trees, averaging eight years, had received a moderate winter pruning. The injury was due entirely to infestation by first brood larvae, at the time an average growth of 4.4 inches had been made. Contrary to the accepted idea, the major injury (83 per cent) was to lateral rather than to terminal growth from the year-old wood. Often, this injury was a gouging of

the fruit spurs, while the growth was still tender enough for feeding, and undersized, and in some instances, deformed fruits resulted. It was found, moreover, that fully 41 per cent of the first brood injured twigs grew no more during the season.

In 1920, the injury to late peach fruit was much greater than in preceding years. About mid-September, an examination made in an old infestation of considerable severity, by actual count of between 3000 and 4000 fruits on trees of the varieties Smock, Heath and Salway, showed infestations of 12, 43 and 58 per cent for these respective varieties.

These facts, and others of lesser importance, emphasize the necessity for, and warrant the publication of, increased knowledge concerning the control of the insect either by natural or artificial means.

## Parasitism

In lack of an effective method of orchard control for the oriental peach moth, those who have published notes have commented hopefully on the fact, that this recently imported insect had become subject immediately to the attack of numerous parasites of our native species. Altogether, no less than nineteen hymenopterous and dipterous forms are known now to parasitize the peach moth in its egg, larva and pupa stages. The writer, in 1918, succeeded in rearing eleven species of parasites, the records of which have been published already.[1] Seven of these species had not been known to attack this insect. During 1919 and 1920, while continuing the study of the peach moth in northern Virginia, further attention was given to parasitism. The list of parasites reared each year has been much the same, the only new record being that of a single species of *Apanteles*[2] taken in 1920. However, in connection with from 1500 to 2000 orchard collected larvae, a number of interesting observations have been made.

Perhaps the most important fact is that parasitism is keeping pace with the increasing numbers of the host. It 1918, parasitism, while attaining and continuing at an average of 35 per cent for small numbers of larvae and pupae during the latter part of the summer, did not exceed 6 per cent in earlier collections. For all three summer broods in 1920, an average of 20 per cent parasitism was recorded, and the averages, 17, 16 and 25, for the first, second and third broods, respectively, show little variation. It has been encouraging, also, to find a uni-

[1]Jour. Eco. Ent., Vol. 12, No. 4, August, 1919, pp. 347-348.
[2]Kindly determined by Mr. S. A. Rohwer, U. S. National Museum.

formity in the extent of parasitism in collections made in the older infestations near the District of Columbia and those more recent and farther removed from the Potomac river.

*Macrocentrus sp.* has been at all times the most abundant parasite taken. In 1920, 132, or 92 per cent of the 143 specimens reared, were of this species. Apparently, it is becoming equally brooded with the peach moth, specimens emerging from the first brood between the dates June 24 and July 8, from the second brood between the dates July 24 and August 7 and from the third brood between the dates August 22, and September 21.

According to Rohwer[3] "the various species of *Macrocentrus* are internal parasites of microlepidoptera, and the overwintering habit will depend on the habits of the host. In most cases, they will overwinter in their cocoons as prepupal larvae."

Under normal conditions, the wintering, cocooned larvae of the peach moth include small numbers of the third brood, and the fourth brood in its entirety. A high degree of parasitism of the third brood affects indirectly, therefore, the number of wintering larvae and the size of the spring brood of moths, upon which the severity of twig infestation is subsequently dependent. However, up to the present time, no parasites of overwintering larvae have been reared, and it seems certain that *Macrocentrus*, and the other parasites as well, have failed to establish themselves as yet in this section of the seasonal life history of the peach moth, and that they still continue overwintering on their native hosts. It may be that this lack of parasitism of the fourth brood is due to its distinctly fruit-feeding habit, as compared with other broods, which may render oviposition by the parasites more difficult. Whatever the cause assigned, this fact, coupled with the low mortality of the insect for the dormant season (about 85 percent of the cocooned larvae have been found to overwinter successfully) accounts probably for its greater abundance in the orchard and the increasing destructiveness noted during the summer of 1920.

## Laboratory Tests With Nicotine

Preliminary laboratory tests, involving 2877 eggs of the oriental peach moth, were conducted by the writer in 1919 to determine the ovicidal value of nicotine sulphate in respect to this species. The results were promising, and have been reported.[4]

[3]Correspondence.

[4]Jour. Eco. Ent., Vol. 13, No. 4, August, 1920, pp. 364-367.

During the summer of 1920, these tests were continued, and on a sufficiently larger scale to give results that would eliminate the chance element present in tests in which only small numbers of eggs are employed. In this study, twenty-six experiments, comprising thirty-eight tests with eighteen insecticides and involving 9894 selected eggs were conducted at the Leesburg Field Laboratory. The results substantiate those obtained in the earlier tests. In addition, interesting data were secured on the relative toxicity of different strengths of nicotine sulphate, when used alone, and also, when used in combination with certain spreaders (caseinate and sea moss) and with an arsenical (powdered lead arsenate).

The method of procedure in these tests was similar to that described in the previous report, The eggs deposited on the foliage of one-year-old peach trees were always examined carefully with a hand lens, so that only well-rounded and apparently viable ones entered into the experiments. In applications, the atomizer was held at a sufficient distance to prevent any drenching of the leaves: only a spray mist hit them. Following applications, eggs were given daily binocular examinations up to hatching, and then, the young larvae were continued under observation for 36 hours.

Three series of tests were conducted, in all of which nicotine sulphate (40 per cent) was employed at the varying dilutions 1-1600, 1-800 and 1-500. In the first series, it was used alone; in the second series, a spreader was added; and in the third series, both an arsenical and a spreader were combined with it. Of the 9894 selected eggs, 4585 were sprayed, and 5309 were reserved as a check. Although an endeavor was made to distribute the eggs uniformly, a greater number were employed in those tests, in which applications were made at the more common 1-800 dilution of nicotine sulphate.

The efficiency, or killing power, of an insecticide is computed here, by deducting the per cent of check eggs not hatching from the percent of sprayed eggs not hatching, and in arsenical combinations, larvae dead 36 hours after hatching.

In the first series of tests, in which nicotine sulphate was used alone, 8.7, 70.3 and 80.5 per cent of the sprayed eggs did not hatch. At no time did more than 10 per cent of the check eggs fail to hatch. The actual percentages of efficiency for the varying dilutions 1-1600, 1-800 and 1-500 were 3.8, 60.4 and 73.5, respectively. The greater dilution gave practically no control, while the 1-800 dilution gave a little less than two-thirds, and the 1-500 dilution an approximately three-fourths control.

Either caseinate or sea moss, as spreaders, were added to the varying dilutions of nicotine sulphate, in the second series of tests. Caseinate, as referred to here, was in all cases powdered casein 1 part and hydrated lime 3 parts thoroughly mixed. The preparation of the sea moss spreader has been described previously. Caseinate was employed at the rate of 1 pound, and sea moss at the rate of 2 pounds, to 50 gallons of water. Inasmuch as there was no appreciable difference in the merits of these respective spreaders, the results are reported as one. The addition of a spreader influenced the effectiveness of the nicotine sulphate, especially in the case of the greater dilution. In the tests of this series, 44.4, 75.4 and 84.5 per cent of the sprayed eggs did not hatch, whereas, an average of 87 per cent of all check eggs were hatching, and in the case of the 1-500 dilution tests, only 4.7 per cent of the check eggs failed to hatch. This increased killing power due to the addition of a spreader is shown by the higher percentages of efficiency, 29.8, 61.4 and 79.7, as compared with the results in the first series of tests, in which nicotine sulphate was used alone.

Nicotine-arsenical combinations (nicotine sulphate at the same varying dilutions and powdered lead arsenate always at the rate of 1 pound to 50 gallons of water), with the addition of a spreader (employed as discussed in the preceding paragraph), constituted the third series of tests. Briefly, the combination of nicotine sulphate with an arsenical, in the hope of killing the young larvae immediately after hatching, did not give satisfactory results. The highest per cent of unhatched eggs in this series was 71.9 in the case of a 1-800 nicotine-lead arsenate-sea moss mixture, and in these tests, as high as 17.8 per cent of the check eggs failed to hatch. The highest percentage of efficiency, 54.1, was, therefore, considerably lower than that recorded in either the first or the second series of tests. Failure, here, is due probably to the commonly observed larval habit of rejecting the first few mouthfuls of food material, when entering twigs or fruit.

Extensive studies of the seasonal life history of the peach moth were conducted in connection with this experimental control work to determine the varying abundance of eggs present on the foliage during the egg-laying periods of the successive broods. The records of the deposition of 12678 eggs, in 1920, show that the dates for the heaviest deposits of eggs on the foliage in northern Virginia, as given in the previous report, are correct within seasonal variations. The dates of heaviest deposition, May 10 to 28 and June 27 to July 9, for the first and second broods, respectively, are quite distinct. The last two broods overlap to such a degree, however, that eggs are present on the foliage

from mid July until late September. The setting of a date for a single application against either the third or fourth brood eggs would be impossible, therefore.

The experimental studies, as reported here, are intended to form the basis of orchard spraying operations, during 1921.

## SOME INSECT PROBLEMS CONFRONTING THE AVOCADO GROWER[1]

By G. F. MOZNETTE, *Assistant Entomologist, Tropical and Subtropical Fruit Insect Investigations, U. S. Department of Agriculture*

In the present day development of horticulture in the Tropics there is no new fruit that is coming into prominence more rapidly or with greater assurance of becoming the basis of a profitable industry than the avocado, often erroneously called the "alligator pear." To many this fruit is still unknown, but its reputation is being more widely established each year. At the present time one may find avocados in many of the fresh-fruit markets in our northern and western cities and the fruit is fast becoming as well known as the grapefruit and pineapple. Its unique character reduces to a minimum its competition with other fruits, while its rich, nutlike flavor is almost universally enjoyed among those who have known it long enough to become familiar with its peculiar charm.

At the present time there are probably several thousand acres of bearing avocado groves in Florida and as many more acres in young groves coming into bearing. Avocado growing also is coming into prominence in southern California as well, where many choice varieties are being planted in orchards. Avocado growing in Florida, however, was established a number of years prior to its introduction into California, so that considerable more is known regarding the different phases of the industry in Florida.

With the growth of the avocado industry various problems have confronted the grower. Knowledge of the best methods of propagation, varieties and location best suited to culture to insure success are only successive steps in the production of a satisfactory crop of fruit. There are still other phases and one of the important ones in connection with successful avocado growing is the insect problem. Like citrus, the avocado is an evergreen and hence is subject to the continual attacks

[1]By permission of the Sec. of Agriculture.

of various insect pests, more so, than the decidous fruits growing in the temperate clime. The insects attacking the avocado in Florida are subject to varying changes of climatic conditions as far as their activities are concerned, which possibly would not attack the avocado growing in a more northern latitude as California. While some of the insects which attack the avocado in Florida may have been introduced, others may be insects which have always been present on native vegetation and have adapted themselves to the avocado as a host.

During the winter season in Florida, the avocado is dormant and the precipitation is greatly decreased from what it is during the summer. At this time of year various enemies attack the avocado which thrive under conditions of little rainfall and low humidity. One of the enemies which attacks the avocado at this time is the Avocado Red Spider (*Tetranychus yothersi*, McG.). In appearance this spider does not differ materially from the other species of *Tetranychus* which attack various other fruits. Unlike other red spiders, however, it confines its depredations to the upper surface of the foliage. Orchards heavily infested with red spiders appear in a short time as if scorched by fire. The foliage turns brown and frequently there is a heavy shedding as a result of their attacks.

Another enemy of this fruit during the winter is the so called greenhouse thrips of the north (*Heliothrips hemorrhoidalis* Bouche') which attacks the avocado in the open. Like the red spider it confines its work to the upper surface of the foliage. Besides producing the pale colored areas to the foliage which later assume a brown color and appear scorched, the foliage also becomes thickly covered with minute drops of blackish fluid voided by the thrips. Eventually the foliage drops prematurely as in the case of the red spider.

The loss generally sustained through an infestation of the red spider and leaf thrips, results in injury to the starch laden foliage of the avocado during the winter. By premature defoliation a set back usually results to the trees the following spring in their activities to set a full crop of fruit. The over wintering foliage should remain on the trees for some time after the blossoming period when new foliage is produced to take its place.

These two pests can be controlled effectively on the avocado by spraying with liquid lime sulphur 1 to 50 with the addition of nicotine sulphate 40% at the rate of 1 to 900 to the diluted lime sulphur with out injury. The powdered lime sulphur has been found to work satisfactorily using 2 pounds to 50 gallons of water incorporating the nicotine sulphate 40% as is used in connection with the liquid lime sulphur solution.

With the approach of spring, various other insect activities appear. Before the avocado tree produces new foliage, the blossom clusters arise from the terminal twigs or from the base of the years' growth The bloom as it appears is attacked by a blossom thrips (*Frankliniella cephalicus* Craw.). This blossom thrips is not the same which attacks citrus in Florida or California. However, it does not differ materially in general appearance from most thrips. It averages about a millimeter in length and in general color is pale yellow. It was first recorded as taken from native acacia-like plants in the mountains of Mexico and it is quite probable that it has found its way into Florida from that country. The injury produced by this thrips is caused by feeding of the young and adults on the individual flower parts. As succeeding generations appear the adults deposit their eggs in great numbers in the stems and pedicles which bear the floral panicles and which eventually hold the fruits as they set to the terminal twigs. The species does not attack the fruit.

It is controlled by spraying with nicotine sulphate 40% solution 1 to 900 with the addition of 2 or 3 pounds of soap added to each 100 gallons of the diluted spray as a spreader.

With the maturing of the bloom and the setting of the fruit, new foliage commences to arise from the floral racemes. As the new growth appears it is attacked by the avocado white fly (*Trialeurodes floridensis* Q.). This white fly is unlike any species which attacks citrus in Florida and California. The adults are small and average less than a millimeter in length and possess pale yellow bodies. The adults which appear at this time emerge from the pupae clustered in great numbers on the lower surface of the older dormant foliage. The adults deposit their eggs in great numbers on the new growth, the larvae which hatch from the eggs pass their existence on the lower surface of the foliage. As the new growth commences to harden, pupae are formed and the adults which emerge later reinfest subsequent new growth put out by the trees. There are three generations with a partial fourth in southern Florida during spring and summer. This species like practically all species of white flies produces an abundance of honeydew in the course of development. This honeydew accumulates on the upper surface of the foliage and fruit. The sooty mold fungus develops in this honeydew deposit eventually giving the avocado foliage and fruit a decided dirty and blackened appearance. The sooty mold adheres rather tightly to the fruit which must be cleaned before shipment, necessitating considerable extra labor. By proper spraying this expense is practically eliminated.

The pest is controlled by spraying with the regular oil emulsion sprays. Two sprayings generally are necessary, one during the spring at a strength of 1 to 80 and another in the fall at 1 to 70.

A question of considerable importance arises in connection with spraying with oil emulsions in southern Florida. The waters which are generally used for spraying purposes come from wells situated in limestone formation and are termed "hard". They generally contain bi-carbonate salts and when combined with oil emulsion sprays at times separation occurs, with the result that free oil is produced which is detrimental to avocado foliage. Softening of the water is necessary when using an oil emulsion which otherwise separates when combined with such water. Recently the oil emulsions are being perfected by the incorporation of organic stabilizers in their manufacture which prevents separation to a marked degree.

At times various scale insects give the avocado grower considerable trouble. One in particular is the Dictyospermum scale (*Chrysomphalus dictyospermum* Morgan), which makes inroads into the tree, attacking the twigs, branches and where numerous, the foliage. Its effect on the avocado is very similar to that produced by the San Jose scale on various deciduous fruits.

Another scale which seriously attacks the avocado is the Pyriform scale (*Protopulvinaria pyriformis* Ckll.). This scale attacks the young foliage in the spring, the immature scales migrating as they hatch from the mature scales on the older foliage. In the process of development of this scale honeydew is produced in practically the same manner as when white flies are present, eventually giving the fruit and tree a decided dirty blackened appearance. The Dictyospermum scale and the Pyriform scale are controlled by spraying with oil emulsion sprays during the dormant season of the year at a strength of 1 to 70.

Various other insects which attack the avocado may cause serious damage at times are: the blossom anomala (*Anomala undulata* Mels.); the avocado tingid (*Acysta perseae* Heid.); the avocado leaf hopper (*Empoasca minuenda* Ball); the cocoanut mealy bug, (*Pseudococcus nipae* Mask.); the black scale (*Saissetia oleae* Ber.); the avocado leaf roller (*Gracilaria perseae* Busck); and the cotton stainer (*Dysdercus suturellus* H. Schf.).

# SOME NOTES ON A NEW AND PROMISING INSECTICIDE[1]

By ERNEST N. CORY, *College Park, Md.*

Routine tests of a new insecticide about to be put on the market by McCormick & Company, Baltimore, Maryland, developed the fact that the material has considerable promise, particularly, in certain fields.

The insecticide is an alcoholic extract of pyrethrum prepared in the form of a heavy liquid soap. It mixes readily with water at any desired strength, spreads evenly and sticks fairly well.

Tests were conducted to determine its efficiency as a contact spray, as a repellent and as a stomach poison. Whether the efficiency could be increased by the addition of more soap was tested and the effect of the spray on foliage and flowers was carefully noted.

The following insects were used: the egg plant lace bug (*Gargaphia solanii* Heid.); two species of rose slugs (*Cladius pectinicornis* Fourer and *Endelomyia rosae* Harr.); the mealy bug (*Pseudococcus citri* Risso.); plant lice on nasturtium (*Aphis rumicis* Linn.); the chrysanthemum aphis (*Macrosiphum sanborni* Gill.); an undetermined aphid on Japanese Barberry, the eggs of the imported cabbage worm (*Pontia rapae* Linn.); the imported currant worm (*Pteronus ribesii* Scop.); and the tent caterpillar (*Malacosoma americana* Fabr.).

## TESTS AS A CONTACT INSECTICIDE

Tests against the egg plant lace bug in the field were inconclusive, therefore, further tests were made on large pieces of infested plants placed in water in the green-house. These plants were sprayed Oct. 5th with a dilution of 1 to 300. After 24 hours 50% were dead and the balance showed feeble movements. Most of the latter had left the plant and were lying feet upwards on the floor of the cage. All finally died after a lapse of 48 hours.

Rose aphids on the tips of roses in the green-house were sprayed Oct. 1st. and March 12th. The first application was made at a dilu-

[1]Contribution from the Entomological Laboratory - Maryland Agricultural Experiment Station. December 20, 1920.

tion of 1 to 100 with a 95% mortality resulting. On March 12th the material at a dilution of 1 to 300 was sprayed and counts showed 650 dead aphids on the sprayed twigs, representing 100% mortality. The check selected, having 200 aphids on it, showed only 9 dead at the time the counts were made on the sprayed bushes.

The bean aphis on nasturtium was sprayed Oct. 5th with a dilution of 1 to 100 resulting in 100% mortality.

On Oct. 6th potted chrysanthemums badly infested with the brown aphis were sprayed with dilutions of 1-100, 1-300 and 1-500 prepared just prior to spraying and 1-300 that had been diluted five days. Examination Oct. 7th showed one live wingless aphid on the plant sprayed with a dilution of 1 to 300, (freshly prepared), and one live winged aphid on the plants sprayed with 1 to 300 (prepared five days). On Oct. 13th three chrysanthemum plants badly infested with brown aphis were sprayed with 1-1000, 1-1500 and 1-2000. Notes made Oct. 14th and 16th disclosed almost complete control. These tests were repeated Nov. 10th on mums in bloom using 1-800 and 1-1000 that had been made up one week from a new lot of the insecticide and 1-2000 that had been made up on Oct. 14th from the original sample. The former application did not control the aphids while the 1-2000 gave complete control. Later it was learned that the second sample was only one-half the strength of the first sample so that for comparative purposes the above solutions would represent dilutions of 1-1600 and 1-2000. Just what factor caused the decided difference, cannot be stated. On May 15th, 1920, Japanese barberry bushes heavily infested with aphids were sprayed at the rate of 1-600. Nearly complete control was obtained in this case.

A very insufficient test of the effect on the eggs of the imported cab bage worm is herewith given for what it is worth. Three lots were sprayed respectively with strengths of 1-100, 1-300 and 1-500. Two lots of two eggs each were retained as checks. One egg in each lot of checks hatched on the 11th of October while none of the sprayed eggs hatched. Mealy bugs on coleus were sprayed with a dilution of 1-100 October 1st with no perceptible beneficial results. On the red spider the results were likewise unsatisfactory.

Field tests on full grown tent caterpillars at a dilution of 1-600 gave 100% control. Laboratory tests at various dilutions from 1-100 to 1-600 gave complete control in all cases, though the time necessary to kill depended upon the strength of the solution and the size of the larvae.

Rose bushes thoroughly infested with the Bristly Rose Slug in the green-house were sprayed with a dilution of 1-100. All slugs were

killed. The native rose slug was sprayed out doors on May 18th with a dilution of 1-600 with practically 100% control. Almost full grown larvae of the currant worm were sprayed in the laboratory on May 19th with dilutions of 1-500, 1-600, 1-700, 1-800, 1-900 and 1-1000. Tak-a-nap soap was used with similar dilutions at the rate of 4 pounds to 50 gallons. Fourteen lots of 10 larvae were sprayed resulting in an average of 66% killed. Very little difference between the weaker and stronger solutions with or without soap prevailed.

## Tests As A Stomach Poison And As A Repellent

The work with the tent caterpillars gave us notes on its effect as a stomach poison and as a repellent. In the laboratory tests with the tent caterpillars, leaves of the wild choke cherry were dipped or sprayed in dilutions ranging from 1-100 to 1-200, allowed to dry from 2 to 4 hours and then placed in vials of water under lantern globe cages or small screen inclosures. Ten larvae were then introduced in eaeh cage; 25 test lots and 5 check lots. In all cases the larvae refused at first to stay on the treated leaves. There was a shrinking of the body and an inactivity on the part of the larvae resulting from confinement with the leaves. Approximately 50% died after a lapse of 5 to 10 days. This indicates a decided repellent and possible toxic action. In one of the large cages though there was plenty of circulation of air, a number of dead and dying larvae were found on the bottom of the cage after they had fed upon the sprayed leaves. In many of the smaller cages, the larvae refused to feed and it is possible that the fumes were the cause of the disinclination to feed. From these experiments we were unable to determine whether the material acted as a stomach poison or a contact insecticide, partly due to the type of cage used, the general inactivity of the larvae and the fact that little eating was done even by those in the check cages, in one set of experiments.

## Summary

Tests indicate that the material has a decided effect as a contact insecticide, repelling powers to a considerable degree and a possible toxic action.

In no instance did the material injure the foliage or spot the most delicate flowers.

The field for the use of this material in green-houses, on flowers and ornamentals and in home gardens seems to be promising. Its application to the control of insects affecting forage, that cannot be sprayed with an arsenical, offers another possibility.

# BIOLOGICAL CONTROL OF THE BLACK SCALE (*Saissetia oleae*) Bern. IN CALIFORNIA

By HARRY SCOTT SMITH, *Chief, Pest Control Service, California Department of Agriculture*

For many years the black scale, *Saissetia oleae* Bern., has held the foremost place as a pest both of citrus fruits and olives in California. It is wide-spread in its distribution and capable of serious injury to either fruit. In fact it would be an impossibility in most parts of the state to grow either citrus fruits or olives without carrying on control measures against this pest. Los Angeles County alone spent $850,000 during the season of 1919 for fumigation of citrus trees, most of which was directed against the black scale, and the total sum expended for this purpose in California exceeds two millions of dollars per annum. This does not take into consideration the expense of washing the fruit, necessitated by the secretion of honey dew, or the reduction in quality or quantity of fruit due to the infestation.

Obviously, in the face of such a staggering tax on production, there is a strong incentive to students of the problem to seek a reduction in the cost of suppression. Biological control has seemed to hold such a possibility.

Following the successful outcome of the biological control work against the citrus mealybug, a study of the applicability of this method to black scale control has been taken up. This method is based on the proposition that, given a host insect of certain type, which is normally attacked by an effective sequence of parasites, fluctuation in numbers between host and natural enemies can be prevented by the continued artificial propagation and liberation of the natural enemies in the infested orchards. The writer has previously pointed out[1] that success with this method is dependent upon certain factors, among which were "Sequence of available entomophagous insects" and "Possibility of rearing or obtaining the entomophagous insects in sufficient quantities." Until recently there was not available for the black scale in California a satisfactory sequence of natural enemies, there being no effective parasite of the intermediate stages of the host in our fauna. *Rhizobius ventralis*, the ladybird introduced by Koebele from Australia, was of considerable importance as a predator on the young scale,

[1]Jour. Econ. Ent. Vol. 12, 1919, p. 288.

and *Scutellista cyanea*, a parasite which feeds on the eggs beneath the parent scale, at times did good work. The introduction into California in 1919 of *Aphycus lounsburyi* How., an effective internal parasite of the immature stages of the scale, fills a conspicuous gap and completes the sequence. At about the same time the writer demonstrated that black scale, like mealybugs, could be grown under laboratory conditions on potato sprouts, so that during the summer of 1919 conditions seemed to warrant an attempt to bring about a control of the pest by the biological method.

Accordingly, in September, 1919, a second insectary was established at Alhambra for the purpose of propagating and distributing natural enemies of the black scale, and two plots of trees selected for the purpose of demonstration, one at Alhambra and the other at Santa Paula, Ventura County, on the Limoneira ranch, where the management had volunteered to maintain an insectary under supervision of the State Department of Agriculture. A block of 54 infested trees on the Limoneira ranch was set aside, unfumigated, for this work. *Aphycus lounsburyi* was colonized on these trees, began breeding with rapidity, and by May of the following year had rendered them commercially free of scale. The Limoneira company were so encouraged by this demonstration that they then set aside a block of 10,000 infested trees. The same performance was repeated, together with colonizatons of *Rhizobius ventralis* and *Scutellista cyanea*, and at the present writing 75% of the scale have been destroyed and there is no doubt but that by spring this orchard, too, will be commercially clean. The *Aphycus* particularly has done wonderful work, the adults literally swarming on the trees on warm sunny days.

It was soon found, however, that while the biological control was apparently a simple matter under certain conditions, under others it was a more difficult problem. At Santa Paula and various other citrus districts along the sea coast, the black scale has an uneven hatch, that is to say, almost any stage of scale may be found at almost any season, although many entomologists insist that there is only a single generation. On the other hand, in the interior districts, the hatch is very even, the scale being largely of one stage at any given time. This has a very important bearing on the propagation of *Aphycus lounsburyi*, the most effective natural enemy, in the orchards. *Aphycus*, breeding on certain stages only, is unable to maintain itself in numbers in those localities where, for a period of several months, those stages of the scale favorable to its development are not present or are very scarce in the orchards. On the other hand, in districts where the scale has

an uneven hatch the parasite breeds uninterruptedly throughout the year and, having many generations to one of the host, is soon able to overcome it.

The work has already progressed to a point where it is safe to conclude that it will be of immense practical value in the control of the black scale, since there are extensive areas where scale conditions are conducive to the uninterrupted breeding of *Aphycus lounsburyi*. Even in the interior, where the problem is more difficult on account of the even hatch, there is reason for optimism, because the problem there is simply a question of quantity production of natural enemies in insectaries with which to restock the orchards occasionally. Sufficient progress has been made on this phase of the work to justify the belief that it can be worked out to a successful conclusion. The most serious obstacle to success in some districts is the presence on the trees of other species of scales which are not destroyed by the enemies of the black scale and which consequently require fumigation. It is hoped that this obstacle may be overcome in part by resorting to spraying, which is much cheaper than fumigation, and by the propagation and distribution of the natural enemies of these other scales, a study of which is already under way.

An interesting development in this project, both from a biological and economic standpoint, is the enormous increase of secondary parasites since the introduction of *Aphycus*. Two species particularly, *Quaylea whittieri* Timberlake and an undescribed species of *Eusemion*, the former normally a secondary on *Scutellista* and other parasites, the latter a secondary on parasites of *Coccus hesperidum*, have increased to enormous numbers in the orchards where *Aphycus* has been established. Just what effect they will have on the practical outcome of the work is of course problematical.

## THE JAPANESE BEETLE QUARANTINE[1]

By C. W. Stockwell, *Riverton, N. J.*

From observations and results accomplished by the quarantine regulations in force against the Japanese beetle for the past two years it seemed advisable to continue this quarantine work, in an endeavor to hold the beetle in check and prevent if possible its widespread distribution over the United States until some adequate means of control might be found.

[1]Published by permission of the Secretary of Agriculture.

As a result of scouting operations during the past summer, beetles have been located in considerable numbers throughout a strip of territory about eight miles in length and some over a mile wide in Pennsylvania along the Deleware River, directly opposite the infested territory in New Jersey. This infestation has necessitated the placing of a State quarantine by Pennsylvania to supplement the Federal and State of New Jersey quarantine orders in force since June 1, 1919. The two state quarantines are identical with that of the United States Department of Agriculture, except that they prohibit without certification the intra-state and the Federal inter-state movement of the articles quarantined.

Previous to April 1, 1920, green or sugar corn was the only article of which shipment was restricted, but at that time regulations became effective to prohibit without certification the transportation from the quarantined area of nursery, ornamental and greenhouse stock including bulbs, throughout the year, and from June 15 to November 1, farm and garden produce of all kinds, as well as flowers in any form.

This insect was first discovered in August 1916 in the vicinity of Riverton, N. J., and since that date has spread over an area of approximately 85 square miles, 75 of which are in New Jersey and the remainder in Pennsylvania. The area in New Jersey is mainly a market garden and fruit growing section with Philadelphia as its chief market, while that in Pennsylvania is largely a residential section with much less of it given up to farming. A considerable number of greenhouses and nurseries fall within this infested area; some of whom handle only cut flowers, while others have a varied line of plants, bulbs and outdoor grown stock.

The present requirements of all greenhouses shipping potted or unpotted plants are as follows: Potted plants must be potted in soil free from grubs, the soil to be considered as such only when sterilized or obtained a reasonable distance outside the known infested area. After potting, these plants must be kept free from infestation. The roots of unpotted plants must be washed free from soil and in the case of ornamentals requiring earth about the roots an inspection is made of the soil about the roots as the tree is dug, also the nursery blocks must be kept in a clean state of cultivation throughout the season of beetle activity and no beetles found in the immediate vicinity. During the past season every attempt has been made to keep greenhouse and nursery surroundings free from attractive food plants and considerable spraying has been done with repellents in an attempt to make

conditions unattractive to the beetles, therefore eliminating if possible the chances of their infesting the immediate surroundings of nurseries and greenhouses.

Regarding the matter of farm and garden produce, as said before these are restricted only from June 15 to November 1, and during that period certification is required of all farm produce passing out of the quarantined area. Farms within the quarantined district but outside the actually infested section are given blanket permits, good until conditions warrant inspection of their produce. Throughout the past season hay was forbidden shipment altogether from the infested zone, as it is impossible to certify a quantity of hay and say that it is free from infestation. All sweet or sugar corn carried out was inspected, this crop is the most likely of any garden produce to harbor beetles inasmuch as the beetles are attracted to it and work their way beneath the husks at the silk end. This past summer, 2,137 baskets of corn were examined and 846 beetles found, a considerable amount of this corn was shipped to points as distant as New York and Pittsburgh. Smooth skinned crops such as apples, pears, peas, melons and tomatoes are very unlikely to be infested if properly handled and graded. One of the principal endeavors has been to get the farmers to take their produce in from the fields as soon as possible after gathering and then generally to regrade or sort under cover, thereby lessening to a decided degree, the possibilities of the beetles clinging to the different articles.

In the case of flowers gathered by individuals and carried from place to place, it is almost impossible to stop this without posting inspectors upon every road leading out of the area also upon every train or trolley passing out. In order to warn people unfamiliar with the requirements, cloth signs were stretched across all principal roads leading out of the infested area, stating that it was unlawful to carry beyond that point, garden and farm produce, flowers, etc., without certification by our office. It is difficult to say just how helpful these signs were but we believe they caused many to hesitate and procure a permit before carrying prohibited articles out of the restricted territory.

The increased area over which the quarantine is in force at the present time will require a somewhat different method of procedure than that in force throughout the past season but from the experience of the past two years adequate plans are being worked out and put into execution to cover this enlarged area.

# IMPORTANT INSECTS COLLECTED ON IMPORTED NURSERY STOCK IN 1920

By E. R. SASSCER, *Washington, D. C.*

During the fiscal year 1920, 11,081,756 plants, not including bulbs and seeds, were offered for entry into the United States from the five principal exporting countries of Europe, which were distributed as follows: England, 1,041,700; France, 9,334,645; Holland, 705,411; Belgium, 1; Germany, 1.[1] The total number of foreign plants offered for entry was 11,423,821, showing a decrease of 5,412,459 as compared with the previous fiscal year. This reduction of foreign plants entering the United States has not, however, resulted in a corresponding decrease in the number of injurious insects arriving on nursery stock; but to the contrary, the list of interceptions, which comprises some well known pests, includes more insects than any year hitherto. In asmuch as a complete list of the insects and diseases intercepted on foreign plants from October 1919 to December 31, 1920 will be prepared in the near future, it is proposed to confine this paper to insects which are known to be injurious.

The Brown Tail Moth was intercepted on eleven occasions on fruit seedlings and stocks from France; and the Sorrel Cutworm (*Acronycta rumicis* L.) was found in one shipment of Mahaleb stock from the same country. Rose stocks from Holland, Scotland, Ireland, England, and France were infested with *Emphytus cinctus* L., and several shipments of bulbs from France and Holland were infested with *Eumerus strigatus* Fallen. and *Merodon equestris* Fabr. One shipment of French Paradise Apple stock was found exhibiting an infestation of the White Tree Pierid (*Aporia crataegi* L.), and a shipment of Rosa rugosa from Holland was found to contain specimens of *Cacoecia podana* Scopoli, which is a general feeder, and not known to occur in the United States.

The Pink Bollworm (*Pectinophora gossypiella* Saunders) was intercepted in cotton seed from China and Japan, and in seed attached to burlap arriving from Egypt and Holland. It has also been intercept-

[1]The number of plants entered from these countries from 1913 to 1919 inclusive will be found in previous reports under the same title published annually in the JOURNAL OF ECONOMIC ENTOMOLOGY.

ed on several occasions on the Mexican Border, having been found in cotton seed and cotton bolls, in suitcases of passengers, and in pillows and quilts. These interceptions were especially fortunate, since the infested seed was in the possession of immigrants enroute to cotton fields where they were to be employed as laborers. Numerous interceptions were made at the port of New York, the most important of which perhaps, was the finding of living larvae of the European Corn Borer (*Pyrausta nubilalis* Hubn.) in a large shipment of Italian broom corn.

A wire worm (*Agriotes lineatus* Fab.) not known to occur in this country, and considered very injurious to cereal crops in Europe, was collected in a shipment of Danish potatoes; and the Potato Tuber Moth (*Phthorimaea operculella* Zeller) was taken on Irish potatoes from Australia, Chili, Peru, and Spain. The Sweet Potato Weevil (*Cylas formicarius* Fab.) was taken in shipments of sweet potatoes arriving from Nassau, Cuba, Mexico, Jamaica, Isle of Pines, and Porto Rico; and the West Indian Sweet Potato Weevil (*Euscepes batatae* Waterhouse) arrived in tubers from Porto Rico. Yams from Jamaica and Cuba were found to contain larvae of *Palaeopus dioscoreae* Pierce and *P. costicollis* Marshall respectively. The black fly of citrus (*Aleurocanthus woglumi* Ashby) was collected on the foliage of the following fruit trees arriving from Cuba at Florida ports of entry: grapefruit, lime, mango, sapodilla; and *Aleurothrixus howardi* (Quaint.) was collected on the foliage of grapefruit from Cuba and the Isle of Pines.

Living larvae of *Anastrepha fraterculus* Weid were collected in guavas, mangoes, Cuban plums, and Sapodillas from Cuba, and what appeared to be the larvae of *A. striata* Schiner were found in guavas from the same country. Mangoes from Spanish Honduras were found to contain larvae of an unrecognized species of Anastrepha. Three insects, representing as many genera injurious to avocadoes were intercepted; viz., *Heilipus persea* Barber, from the Canal Zone; *Stenoma catenifer* Walsh, from Spanish Honduras; and what appears to be *Conotrachelus persea* Barber from Costa Rica and Mexico. The last named insect was found quite abundant in avocadoes for sale in the markets of Nuevo, Laredo, and Piedras Negras during the months of May and June. *Metamasius sericeus carbonarius* Chev. was collected on several occasions in shipments of bananas arriving from Guatemala and Spanish Honduras. In addition to the above some eighty distinct species of scale insects were found on plants offered for entry, many of which are not at present established in this country.

### Insects in Soil

During the past year, several shipments of plants arrived containing soil about the roots in violation of Quarantine 37 which provides that such plants shall be "free from sand, soil, or earth." Four such shipments were found to contain injurious insects. Larvae of a species of Agriotes were contained in soil surrounding the roots of a Sunstar rose from Ireland, and what appears to be an injurious curculionid larva was found in soil around a Japanese iris from France and soil around Stilbe roots from Holland. Evergreen shrubs from Holland were found to contain the European Earwig (*Forficula auricularia* L.), and herbaceous ornamental plants from the same country contained in the soil surrounding the roots, *Otiorhyncus sulcatus* Fab.

Perhaps the most important soil interception was the finding of *Leucotermes tenuis* Hagen in soil around plants arriving from Brazil. This termite is considered the most destructive species in the world, and has been found in Santo Domingo, the Bahama Islands and Brazil. It is reported that this termite was introduced into the island of Saint Helena and was so destructive at Jamestown, the capitol, that new buildings had to be erected.

## THE EUROPEAN RED MITE (*Paratetranychus pilosus* Can. & Fanz.) IN CONNECTICUT

By Philip Garman, Ph.D.

A mite which seems to be *P. pilosus* Can. & Fanz. appeared last summer in destructive numbers in Connecticut orchards. It was noticed on leaves brought from the field at Milford April 25, by M. P. Zappe, but the first signs of injury were noted by Doctor Britton at Milford about July 2. At this time several trees in an orchard showed a premature rusty appearance, and the leaves were found to be inhabited by many mites. Later a much larger orchard was reported to be infested, and during the summer it was found in four additional localities.

### Difference From Other Economic Species

As the name above suggests, the mite is usually red in color, thus contrasting with the ordinary *T. bimaculatus* which is more often greenish or yellowish. The setae of the dorsum are large, arise from tuber-

cles and are pilose. The egg is usually more or less flattened above and striate, being thus different from the glistening spherical egg of *T. bimaculatus*. There may also be seen a short erect column arising from the upper surface which is usually about equal in length to the diameter of the egg. The tarsi are provided with long hook-like claws, which are lacking in *bimaculatus*. Other microscopical features are also shown in Fig. 7, 1-10.

The mite is still more unlike the clover mite, *Bryobia pratensis*, since the latter is much larger, dark bluish or purple in color when adult and is provided with a number of plates around the margin of the body. The egg of the clover mite is also larger than the red mite, being .19 mm. in diameter instead of .15; and does not possess the central stalk.

## Occurrence in Connecticut and Elsewhere

This is the first record of the appearance of the mite in Connecticut but it was noticed in Pennsylvania in 1919,[1] by Caesar[2] in Ontario in 1915, and has been studied extensively in Sweden by Trägardh[3] in 1915. It was originally described from Italy in 1877-8 and probably has a much wider distribution than indicated here.

In Connecticut it has been found in New Haven, North Haven, Branford, Milford, Meriden, Middletown, Greenwich and Danbury.

## Common Names Used for the Mite

Trägardh calls it the fruit-tree spinning mite, Caesar the European plum mite, while in Italy it is known as the rose mite. The name used in this paper is merely a descriptive title and should not be followed unless passed upon by the nomenclature committee of this society.

## Nature of Injury to Host

Thus far it has been taken in Connecticut on apple, cherry and rose, but has not been collected from plum. On apple the most noticeable effect of the infestation is a browning of the foliage, but some trees assume a dull leaden appearance. Late in summer the trees lose a good many leaves, and the size of the fruit appears to be affected. Thus

[1] Journ. Ec. Ent., 12: 407-8: 1919.
[2] Can. Ent., xlvii: 57-58: 1915.
[3] Rev. Appl. Ent., IIIA: 254: 1915 (Abstract).

in several selected Baldwin trees, 19-24% of the fruit was 2¼ inches in diameter (the remaining 76-81% being smaller) while in uninjured trees of the same age in the same neighborhood, 44-60% of the fruit attained this size. One tree observed the latter part of September had hardly any fruit fit to sell.

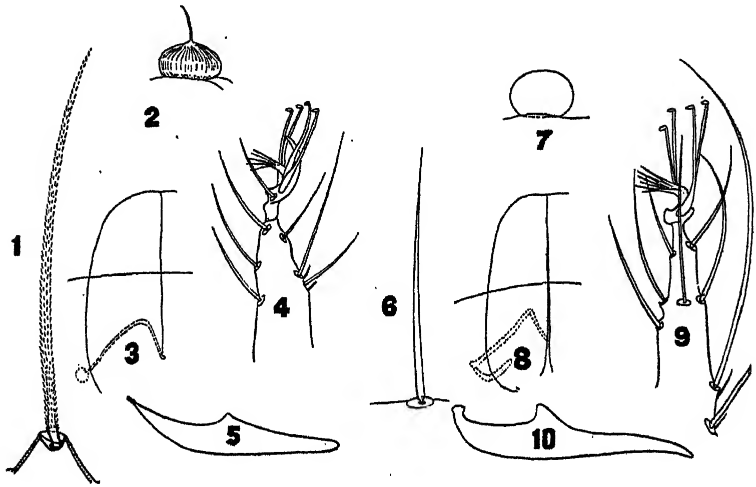



Figure 7. Structures of European red mite *Paratetranychus pilosus* Can. and Fanz. and common red spider *Tetranychus bimaculatus* Harvey.

1, *Paratetranychus pilosus*, seta of dorsum 846 times enlarged; 2, egg, 14 times enlarged; 3, collar trachea and mandibular plate, 714 times enlarged; 4, tarsus of first pair of legs of female, 921 times enlarged; 5, penis, 1400 times enlarged.

6, *Tetranychus bimaculatus*, seta of dorsum, 846 times enlarged; 7, egg, 14 times enlarged; 8, collar trachea and mandibular plate, 714 times enlarged; 9, tarsus of first pair of legs of female, 921 times enlarged; 10, penis, 1400 times enlarged.

Baldwins are more easily injured than other varieties, but some browning was noted on McIntosh, Hurlburt and Ben Davis. Greening is resistant and although infested did not show the effects of the infestation.

## How Long Has It Been in Connecticut?

In order to become so widely distributed, the pest must have been present in the State for some time. Mites reared from eggs obtained in 1919 appear to be the same species as those obtained later. In looking over our slide collection, a single slide was found containing mites from apple leaves, collected by Mr. Zappe at Clintonville, a point near

New Haven. This slide, made in 1917, contains the same species. It has therefore been present in the State for three years and possibly longer.

## Means of Dispersal

Apples examined in the field frequently showed an abundance of small red eggs placed well within the calyx cavity. Probably they are thus carried from place to place on the fruit, and under favorable circumstances may hatch and regain a host. There is also considerable local distribution by winds.

## Possibilities of Control

Our limited experience in controlling this mite under Connecticut conditions indicates that possibly the commercial lime sulphur (1-9[1]) applied as a late dormant spray may prove effective. Certainly none of the summer treatments applied July 28, in one orchard where four different combinations were used, gave results that would warrant such treatment by the grower. In this laboratory, laundry soap, 4 lbs. in 50 gals. of water, killed nearly all of the mites with which it came in contact; but before we understand how to control this pest much more work must be done, especially in the line of field tests and observations under local conditions.

**Blister Beetle Injury to Peaches.** Blister beetles, identified as ***Pomphopoea aenea*** Say, caused considerable injury in a peach orchard at Marshallville, Georgia on March 10th. The trees were in full bloom on that date and the beetles attacked the blossoms, eating through the calyx and then devouring the pistil. Very often the young foliage just putting out was eaten. An army of these beetles had destroyed all blossoms on about fifty trees in a 4000-tree orchard before they were observed. Hand picking was advised immediately and with the assistance of an application of arsenate of lead, and early morning jarring the outbreak was checked within twelve hours.

Oliver I. Snapp, *Entomologist,*
*U. S. Entomological Laboratory,*
*Fort Valley, Georgia*

[1]Since writing the above it has been found that miscible oils like scalecide are very effective ovicides.

# NOTES ON THE LIFE HISTORY AND THE CONTROL METHODS OF THE BOX WOOD LEAF MIDGE, (*Monarthropalpus buxi Labou.*)[1]

By C. C. HAMILTON, *College Park, Md.*

The Box Wood Leaf Midge is a small, frail, yellow Cecidomyid, the immature stages of which are found in the leaves of box wood plants. Here it causes characteristic gall-like swellings (pl. 4, fig. 3) and in cases of severe infestations the dropping of the leaves, results in a ragged and unsightly bush or hedge. This pest was apparently introduced from France or Holland in imported box wood plants. Felt in 1910 records its first appearance in the United States at Kingston, R. I. Since then it has been reported from a number of states along the Atlantic coast and from California.

It is the purpose of this paper to give a summary of the most important phases in the life history of the insect and some of the more promising methods for controlling it.

## LIFE HISTORY AND BIOLOGY

In the vicinity of Baltimore, Maryland, the insect passes the winter as a partly grown larva, molting at least once in the spring before pupating. Pupation commences about the first of May and continues until the latter part of the month, the majority of the larvae pupating from the 8th to the 12th. The pupal stage lasts from two to three weeks with an average of sixteen or seventeen days. When ready to emerge the pupa pushes its way through the lower surface of the leaf until all but the last five or six abdominal segments are out. It then crowds the body forward in the pupal skin until the skin splits along the dorso median line of the thorax. From five to ten minutes are required for the adult to emerge from the pupal skin with an additional two to five minutes before the wings have expanded and the adult is able to fly away. It is in this period, from the breaking of the leaf

[1]Contribution from the Entomological Laboratory Maryland Agricultural Experiment Station - December 20, 1920.

until the adult has emerged and is able to fly, that the insect can be most easily controlled. At Baltimore the first adults emerged on the 19th of May and the last adults noticed were flying on the 2nd of June The maximum emergence occurred May 26th.

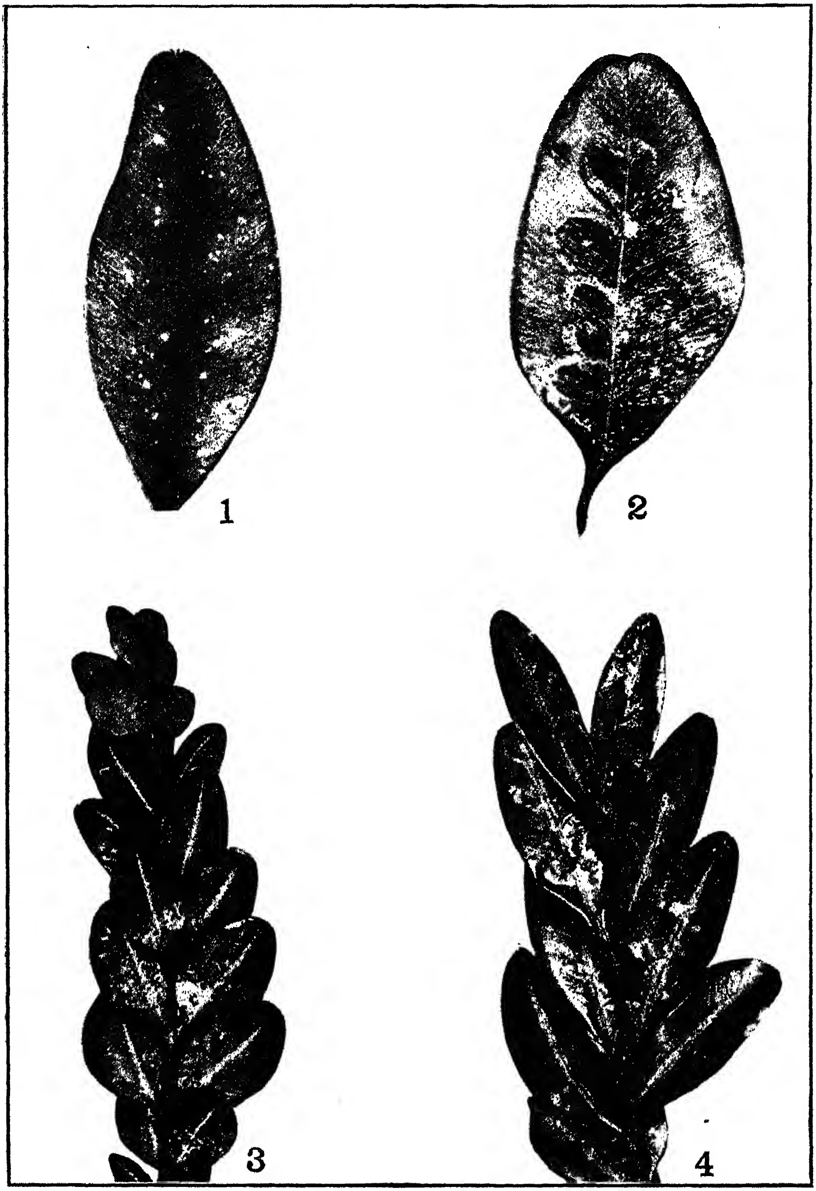
The eggs are inserted by the female from the underside of new leaves by means of the curved, pointed and needle-like ovipositor which slits the ventral surface. The ovipositor apparently stretches the tissues of the leaf and permits the egg to be forced through as no slit in the leaf surface could be found shortly after the eggs were laid. The time required for the deposition of a single egg varied from three to eight minutes, with an average of five and one-half minutes. In a number of cases females were observed to lay four and five eggs in succession in the same leaf.

In the box wood hedge at Baltimore, egg laying was first observed on May 20th, with the maximum occuring on the 26th. In the laboratory 25 adults, 9 males and 16 females, emerging at 10.00 P. M. May 26th were placed in a lantern globe cage with fresh leaves. Mating was observed early the next morning and by noon the females had begun to lay eggs, and continued until evening. No mating or egg laying was observed after the 27th. The first adult, a male, was dead the the morning of May 27th and the last adult died the evening of May 30th. Two hundred and ninety eggs were laid in the leaves, or an average of eighteen for each of the sixteen females. All of the females had eggs remaining in the ovaries when they died. A count of the eggs in the ovaries of newly emerged females gave an average of fifty-four for each adult.

The egg is white to transparent, oval and averages .27 mm. in length by .16 mm. in diameter. The covering is smooth, tough and pliable. The length of the egg stage varied from twelve to eighteen days.

The larva when first hatched is grub-like, pointed at both ends and remains curled up in the place where it hatches until after the first molt. After the first molt it becomes straight and assumes the shape characteristic of the cecidomyid larvae. The larvae grow slowly and by October or November they have molted three or four times, are about 1.5 mm. in length and are yellowish-green in color. From an examination of the stomach of a large number of larvae and from the structure of the mouth-parts, there is no evidence that they take solid food. In the early instars the food is evidently absorbed through the body and in the later stages the large juicy parenchyma cells are punctured by the breast bone and the juices sucked in through the mouth.

PLATE 4.




1, Leaf of boxwood plant showing eggs (by transmitted light); 2, Lower surface of the leaf removed showing the gall-like growth caused by the larvae; 3, Twig showing injury to leaves and pupal skins left in exit holes; 4, Adults killed before completing their emergence by spraying twig with black-leaf-40, 1 to 500.

## Control Methods

Attempts have been made to control the insect under a variety of methods by different workers. Some of these include spraying with arsenical poisons to kill the adults. This work was entirely without results as the mouth parts of the adults appear rudimentary and it is probable that they take no food after emerging. Dusting with sulfur, road dust and other dusts has been tried in France with some success. The dust acts as a mechanical barrier and repels the adults when laying their eggs. Since it does not kill the insect but drives it to unprotected places, its use is not desirable if other methods for controlling it can be found. Spraying with a number of contact sprays to kill the eggs, larvae, pupae, and adults has been tried with varying success. The best results were secured by spraying when the adults were emerging. Fumigating during the larval stage with potassium cyanide, carbon disulphide, ammonia, and other gases has given some control in laboratory experiments. There are no records of its having been tried under field conditions. The only gases which killed the larvae without injuring the plants were hydrocyanic acid gas and carbon disulphide. Spraying with molasses to entangle the adults as they emerge and when laying eggs has given promising results.

The work reported upon here consists of laboratory and field experiments with molasses as a sticker, various contact sprays and fumigation with potassium cyanide and carbon disulphide.

## Preliminary Experiments to Control the Adults

On May 20th, 1920, sections of an infested box wood hedge at Baltimore, Maryland, were sprayed with the following materials:

Lot No. 1. Karo syrup 1 gallon, water 2½ gallons, extract of pyrethrum 10 cc. The material spread well and upon drying gave a uniform sticky surface on new and old leaves.

Lot No. 2. Karo syrup 1 gallon, water 5 gallons, extract of pyrethrum 20 cc. This spray did not spread quite as well on new leaves as Lot No. 1.

Lot No. 3. Karo syrup 1 gallon, water 5 gallons, copper sulphate 2 ounces. (The copper sulphate was added to determine whether it would prevent mold from growing on the syrup). This lot spread the same as Lot No. 2.

Lot No. 4. The same as Lot No. 3 except that dry pyrethrum was dusted on after spraying. Spread the same as Lot No. 2.

Lot No. 5. The same as Lot No. 3 except that Corona dusting tobacco was dusted on after spraying. Spread the same as Lot No. 2.

Lot No. 6. Soluble pine tar diluted one part to ten parts of water. Spread very well on new and old leaves.

Lot No. 7. Soluble pine tar diluted one part to twenty-five parts of water. This did not spread quite as well as Lot No. 6 on the new leaves.

At the time of spraying, the adults were just beginning to emerge, probably less than 1% being out. An examination on May 21st showed that lots 1 to 5 inclusive, gave excellent results, entangling most of the adults as they emerged. Lot No. 1 gave slightly better results than the others. The extract of pyrethrum and pyrethrum dust in lots Nos. 3 and 4 did not kill any of the adults as they emerged, while lot No. 5, dusted with tobacco, killed most of the adults before they emerged completely and entangled the remainder. Lots Nos. 6 and 7, sprayed with the soluble pine tar, killed and entangled a few of the adults as they emerged but caused considerable burning.

## Spraying With Molasses to Entangle the Adults

At the time the examination of the preliminary experiments was made the adults were beginning to emerge quite rapidly, about 10% being out, so arrangements were made to spray the entire hedge of about 175 yards with molasses on the next day, May 22nd. An unsprayed hedge on a nearby estate was used as a check. Black sorghum molasses diluted one part to three parts of water was used. This strength was used as the weaker dilutions did not spread well upon the new leaves and enough more spray material was used to make up for the greater dilution. It took 23 gallons of syrup, costing 50 cents a gallon to spray the hedge. Before spraying, many adults were observed flying and ovipositing. After spraying only a few unentangled adults could be found.

The sprayed hedge was examined on May 26th, at which time the adults were emerging in the greatest numbers. Very few adults were observed flying while many were stuck in the molasses on the leaves. A count of a number of sprayed twigs gave the following results: Adults emerged 652, adults entangled 557, number of leaves examined 280, number of eggs found 591, average number of eggs per leaf 2.1–, or slightly less than one egg for each adult emerging.

In the check secured by examining twigs of the same degree of infestation from an adjoining estate, 233 leaves were examined and 2351 eggs found or an average of $10^{n}$. Based on the average egg infestation in treated and check leaves, there is an apparent control of 79%.

The entire hedge was resprayed the afternoon of the 26th using the same dilution as before. Twenty gallons of syrup were used for the

second application, making a total of 43 gallons. At 50 cents a gallon this gave a cost of $21.50 for materials.

A final count after the adults had all emerged gave an average infestation of 2 eggs per leaf in the sprayed hedge and 10.1 per leaf in the unsprayed hedge. This is an apparent control of 80%. As high as 68 eggs were found in a single leaf in the unsprayed hedge. Had the first spray been applied before the adults began to emerge, approximately a complete control might have been secured. To secure the best results it will probably be necessary to spray three times during the emerging period and oftener if it rains. The syrup did not mould and remained quite sticky until the 10th of June when it was washed off by a heavy rain.

## Laboratory Experiments with Contact Sprays

Branches of the infested box wood plants were secured at Baltimore, brought to the laboratory and placed in water. After spraying with the desired material they were placed outdoors in the field insectary. Every effort was made to keep the twigs fresh as it was found that the larvae soon died in wilted or old leaves. Spraying experiments were started during the pupal stage and continued through the emerging and egg laying periods and up to late fall. Table No. 1, sprayed May 18th, gives some of the materials tested and the results secured.

Table No. I

| Material used | No. emerged successfully | No. failing to emerge successfully | No. adults stuck to leaf | Remarks |
|---|---|---|---|---|
| 1. Syrup 1-5 | 91 | 0 | 21 | Many eggs deposited in new leaves. |
| 2. Syrup 1-10 | 53 | 0 | 9 | ditto |
| 3. Syrup 1-5 + 10 drops carbolic acid to 20 cc. | 49 | 0 | 9 | ditto |
| 4. Syrup 1-5 + ½ gm. HgCl to 20 cc. | 6 | 0 | 10 | No new leaves. |
| 5. Syrup 1-5 + 10 drops creosote merck to 20 cc. | 79 | 0 | 15 | Strong odor, but not lasting. A few eggs laid. |
| 6. Syrup 1-5 + B. L. 40 1 to 100 | 0 | 27 | 5 | No eggs laid. 15 dead pupae in leaves. |
| 7. Syrup 1-5 + pyrethrum extract 1-100 | 49 | 9 | 30 | No eggs laid. No new growth. |
| 8. Syrup 1-2.5 + pyrethrum extract 1-100 | 112 | 9 | 87 | New growth sticky. Very few eggs laid. |
| 9. Syrup 1-5 + pyrethrum powder 1 gm. to 20 cc. | 141 | 0 | 27 | Not sticky after drying. Very few eggs laid. |
| 10. Syrup 1-5 + corona dusting tobacco 1 gm. to 20 cc. | 18 | 43 | 21 | Not sticky after drying. No eggs laid. |
| 11. Pyrethrum extract 1-100 | 116 | 0 | 3 | Eggs common but not numerous in new growth. |
| 12. "Pinetrex" 1-25 + pyrethrum extract 1-100 | 130 | 0 | 8 | Slightly sticky. A few eggs laid. |
| 13. "Pinetrex" 1-25 + B. L. 40 1-100 | 36 | 41 | 0 | Very few eggs laid. |
| 14. Pinetrex 1-25 | 57 | 7 | 4 | Eggs common but not numerous. |
| 15. Pinetrex 1-50 | 56 | 6 | 5 | ditto |
| 16. Pinetrex 1-10 | 84 | 1 | 3 | Fairly sticky. Only a few eggs laid. |

Lots numbers 1 to 4, 5 to 8, 9 to 12, and 13 to 16 inclusive were placed together in screen cages. Lot number 7, consisting of syrup diluted one part to five parts of water plus Black Leaf 40, one to 100, gave the best results. No adults emerged successfully, 27 being killed befor completing the emergence and 15 pupae dead in the leaves. Lot number 10, in which tobacco dust was added to the syrup gave good results, 18 emerging successfully, 43 failing to emerge successfully, and 21 entangled in the syrup. Lot number 13, consisting of soluble pine tar plus Black Leaf 40 gave good results while the tar used alone did not show much promise.

Later experiments with Black Leaf 40 and Black leaf-resinate diluted 1 to 500 gave excellent control. The following table is typical of the results secured.

TABLE NO. II - RESULTS SECURED BY SPRAYING INFESTED TWIGS WITH BLACK LEAF 40 AND BLACK LEAF-RESINATE DILUTED ONE PART TO 500 PARTS OF WATER

| Spray material | No. adults emerging successfully | No. adults failing to emerge successfully | No. pupae dead in the leaves | Percent killed |
|---|---|---|---|---|
| Black Leaf 40 | 5 | 28 | 55 | 94.3 |
| Black Leaf resinate | 4 | 40 | 111 | 97.4 |
| Check | 24 | 1 | 4 | 17.2 |

A good killing effect was obtained 4 and 5 days after spraying. Figure 4 shows the adults killed as they emerged after having sprayed the leaves with Black Leaf 40 diluted 1 to 500. Unfortunately, the adults emerged so rapidly that no time was available for testing Black Leaf 40 under field conditions. Soap added to the spray at the rate of 4 pounds to 50 gallons of water gave slightly better results by increasing the wetting properties of the spray. The results secured in the laboratory tests would indicate that the adults might be controlled under field conditions by spraying at intervals of 4 or 5 days during the emerging period.

Spraying experiments with Black Leaf 40, pine tar dilutions, and pyrethrum extract during the egg and larval stages gave only slight control.

## FUMIGATION EXPERIMENTS WITH HYDROCYANIC ACID GAS AND CARBON DISULPHIDE

Laboratory experiments with hydrocyanic acid gas and carbon disulphide gave results approximating those reported by Felt in the Journal of Economic Entomology for 1915. Young larvae in infested

twigs fumigated with potassium cyanide at the rate of one and two ounces per thousand cubic feet of air space for two hours killed approximately 70% of the larvae, without any injury to the leaves. When the time was increased to six hours, using the same strengths, all the larvae were killed but considerable wilting of the leaves resulted. Carbon disulphide at the rate of 20 drops to 720 cubic inches for 70 minutes killed 60% of the larvae. The dose was increased to 40 drops and 85% of the larvae were killed. No injury resulted to the plants in either case. In the check twigs 30% of the larvae were found dead. The results in the different fumigation experiments varied considerably and considering the attending danger it would probably not be advisable to fumigate for control under field conditions.

## Summary

1. The adults may emerge from the middle of May to early in June. They commence laying eggs soon after emerging and then die.
2. The best time for controlling the insect is while the adult is emerging from the pupal skin.
3. Spraying with molasses, diluted one part to three parts of water, gave the best results, entangling the majority of the adults as they emerged or before laying eggs. The under surface of the old and new leaves must be thoroughly covered with the molasses spray, and the spraying must be repeated often enough to keep them sticky.
4. Laboratory experiments, spraying once with Black Leaf 40 and once with Black Leaf-resinate, diluted one part to 500 parts of water, killed approximately 80% of the adults before they emerged successfully. A killing effect was noted four and five days after spraying. Spraying should probably be repeated at intervals of not less than four or five days during the emerging period.

# INJURY TO STRUCTURAL TIMBER BY LEPIDOPTEROUS LARVAE

By THOS. E. SNYDER, *Bureau of Entomology, U. S. Department of Agriculture*

Recently, Mr. T. D. J. Fuller, an architect of Washington, D. C., called Mr. C. L. Marlatt's attention to the injury done by "fleshy worms" to cypress pilasters of a beautiful new residence being built on the forested bank of the Potomac River about one mile north of Chain Bridge. At the request of Mr. Marlatt, I made an examination of the building on October 15, 1920, anticipating that the damage would probably be due to either Bostrichid or "ambrosia" beetles.

A superficial examination of the damaged pilasters, which had been well painted with a white lead paint previous to attack by insects, confirmed this preconceived diagnosis. Small circular holes about $\frac{1}{8}$ inch in diameter were found penetrating the wood not only of the pilasters but were also in cypress columnar (hollow) pillars, window sills, frames and other woodwork, all of which had been painted. The holes were especially numerous at cracks and points of juncture, such as the molding of the pilasters, etc., which is normally the case in Bostrichid damage, the insects being enabled to obtain a purchase or support by means of which the wood is more easily penetrated. The wood at such places looked as if it had been "riddled" with BB shot. In quite a few instances, especially where the insects had attempted to enter the wood at a distance from cracks or joints, the holes were incompleted, i.e., only slightly penetrated the wood.

What was my surprise upon inserting forceps into one of the completed holes to pull forth a wriggling Lepidopterous larva with "sordid white"[1] body and brown head, about one inch long. Further examination showed that the larval burrows branched at right angles to the entrance holes and extended longitudinally with the grain of the soft cypress wood either up or down the pilaster. The burrows were only slightly wider than the larvae. Sometimes frass protruded from the entrance holes, being loosely held together by webbing.

These larvae were submitted to Mr. Carl Heinrich for determination and proved to be the Polygonum feeder (*Pyrausta ainsliei* Heinrich), a native American species of the family *Pyralidae* closely related to the notorious European corn borer (*P. nubilalis* Hübner). *Pains-*

*liei*, according to Heinrich,[1] has the following food plants: *Polygonum* ("jointweed", "knotweed", "smartweed"), *Ambrosia* ("ragweed", "wormwood"), *Xanthium* ("clotbur", "cocklebur"), *Eupatorium* ("Joe-Pye Weed"), and corn, etc.

The insect, according to Heinrich,[1] occurs from Quebec south to Tennessee.

The house is set in open woodland with undergrowth of weeds, which also occur along the private road leading from the Fairfax "pike" to the house. Joe-Pye Weed was growing along the private road of this estate and its fruit was ripe. A small patch of corn still stands near the house. The larvae merely bored into the soft cypress wood for hibernation quarters, not feeding on the wood at all and hence not being deterred by the paint. Very probably larvae are also hibernating in the dry corn stalks.

Remedies suggested were to mow down and burn the weeds and the corn stalks. Carbon disulphid was inserted into the holes in the woodwork of the house by means of a medicine dropper and the entrance plugged with putty and then painted over. It was suggested that some of the badly bored molding of the pilasters be replaced.

From past experience it was not believed that any chemical preservative treatment of the wood would be of any value since the treatment would necessarily have to be superficial. At Falls Church, Va., on October 31, 1916, brown cocoons spun by large Lepidopterous larvae (*Notodontid*) were found on an experimental yellow pine 2″ x 4″ x 3′ stake, which had received a heavy treatment with creosote. In spinning the cocoons the larvae had cut oval hollows to the depth of $\frac{1}{8}$ inch into the wood, in order to form a protective base for their cocoons. Mr. Heinrich has identified these larvae as *Cerura multiscripta* Riley, adding the statement that:

> The larva of this genus normally scoops out a hollow in the wood of trees, shrubs or other convenient things, using the chips in making the cocoon which is a covering over the hollowed-out place. They do not feed on the woody tissue or otherwise attack it.

Mr. H. S. Barber states that several years ago Lepidopterous larvae made similar excavations in the cypress shingles roofing the cabin at Plummers Island, Md.

Since these larvae were not deterred by the creosote treatment—and coal-tar creosote is one of the most effective wood preservatives known—

[1]Heinrich, Carl. Note on the European Corn Borer (*Pyrausta nubilalis* Hübner) and its nearest American Allies, with Description of Larvae, Pupae, and One New Species. Jour. Agric. Res., Vol. XVIII, No. 3, Nov. 1, 1919, pp. 171-178.

boring into timber by Lepidopterous larvae for the purposes of hibernation or transformation cannot be prevented by chemically treating the wood. The wood excavated is not eaten.

Mr. August Busck states:

> In the fall of 1901 or 1902 a similar extensive infestation was observed by me in a new cypress fence and the corner post of a chicken house in the N. E. suburbs of Washington, D. C. Hundreds or more larvae were dug out. Mr. T. Pergande thought these were a *Pyrausta* larva infesting an adjoining corn field.

In November 1919 the Superintendent of Shops of the Atchison, Topeka and Santa Fe Railway Co., Los Angeles, Calif., reported that refrigerator car No. 4901 "came in full of worms. There are thousands of these worms in this car and they are literally demolishing it." *** "This is the second car of this kind that we have had in here recently."

Samples of the damaged wood from this car were sent by the Superintendent and showed that the damage had been done by medium sized Lepidopterous larvae which had cut into the wood in order to obtain a sheltered and protected place to spin their cocoons and for transformation and not to feed on wood. Larvae and chrysalides in cocoons were found in cavities scooped into the wood. Mr. Heinrich identified the insect as a species of *Olethreutidae*, a group formerly included under the old family *Tortricidae*.

In this case the damage was more or less superficial and the wood was probably not structurally weakened but of course the appearance of the car was ruined.

Mr. J. A. Hyslop has given me a specimen of the white pine woodwork of a beehive from Montgomery Co., Md., which has been badly grooved by the destructive wax-worm or the larvae of the bee-moth (*Galleria mellonella* Linn., family *Galleriidae*), one of the microlepidoptera. Such damage to beehives is not uncommon in the United States. F. B. Paddock[1] states:

> Although the frames and hive are eaten out for pupation it is doubtful if the wood is a food, but probably it is used slightly in the construction of the cocoon.
>
> The larva prefers to get into a place which it can chew in order that a cavity may be constructed and the cocoon thus be better protected.

[1]Paddock, F. B. "The Beemoth or Waxworm." Bull. No. 231, Texas Agric. Exp. Sta., June, 1918.

.It is believed that these instances of damage to timber by phytophagous but non-wood-boring Lepidopterous larvae are unusual and of especial interest; however, such damage is of only occasional occurrence and more or less accidental. Nevertheless, the damage to the railway car in California and the building in Virginia is of no little economic importance. Of particular interest is the instance of damage to creosoted wood.

# NOTES ON THE CARPENTER WORM (*Prionoxystus robiniae* Peck) AND A NEW METHOD OF CONTROL

By H. E. Burke, *Specialist in Forest Entomology, Forest Insect Investigations, Bureau of Entomology, U. S. Department of Agriculture*

One of the worst pests of the native live oak (*Quercus agrifolia*) and the introduced elms (*Ulmus campestris* and varieties) in California is the carpenter worm. The trunks of many of the finest street and yard trees are riddled by its large winding mines. The dirty brownish borings cover the bark and the ground at the bases of the trees and the entire trunk takes on a very disagreeable appearance. As the work continues year after year and the tree tries to heal over the wounds, the bark becomes roughened and unhealthy looking and the tree apparently is more susceptible to new attacks. Fortunately most of the mining is done in the wood and for a number of years the health of the tree appears to be little affected. In the worst cases, however, the tree is unable to overcome the repeated attacks and dies.

The writer has seen live oaks killed by this species at Palo Alto and Santa Barbara and elms in San Jose. There are some heavily infested trees at Los Gatos. Mr. R. D. Hartman observed the work to be common in the live oak in the Niles canyon in Alameda County and Mr. C. M. Packard reports elms badly infested in Sacramento.

Besides the live oak and the elm, the California hosts of the carpenter worm observed by the writer are the white oak (*Q. lobata*), the willow (*Salix lasiolepis*) and probably the cottonwood (*Populus trichocarpa*). We have not found it in the black locust (*Robinia*) which was the original host reported in the Eastern states. An attempted introduction in the blue oak (*Q. douglasii*) failed. Childs (Month. Bul. Calif. State Com. Hort., Vol. 111, p. 264) gives locust and carob as additional hosts.

On September 14, 1917 a heavily infested live oak, fourteen inches ni diameter and with a main trunk height below the branches of about ten feet, was found in the grounds of the Forest Insect Laboratory at Los Gatos. Larvae, apparently from eggs laid in 1916, from three fourths to one inch long were found in mines in the bark and on the outer surface of the wood. Larger larvae, apparently from several older generations, from two and a half to three inches long were found in mines which ran deep into the wood. Reddish borings were common on the bark and on the ground at the base of the trunk. The infestation extended from the ground into the bases of the larger branches.

The tree offered such a good chance for life history work that a cage was built around the main trunk. This consisted of a light redwood framework, three feet by three feet square and ten feet high, sixteen mesh galvanized wire screen walls with a door in one side and a canvas top closely fitted about the trunk and the bases of the larger branches.

That such a cage is well worth its cost is proven by the interesting results obtained. In 1918 seven moths emerged and were captured. Six were males and one a female. In 1919 nine emerged, five males and four females and in 1920 thirty-four emerged, fifteen males and nineteen females. This makes a total of fifty moths reared in the cage during the three years. Twenty-five of these are males and twenty-four females. Besides the moths reared in the cage nine males were attracted to the cage from outside trees. Five of these came in 1919 and four in 1920.

In 1918 the first emergence occured on May 21st, in both 1919 and 1920 it occured May 19th. The last emergence of the year occurred June 12 in 1918, June 24 in 1919 and June 21, 1920. Nineteen of the males were found in the cage during the forenoon hours and seven during the afternoon while fourteen of the females were found in the forenoon and ten in the afternoon. All of the males attracted from the outside came in the afternoon.

It should be noted here that all of the moths that emerged in the cage were taken out as soon as noticed so that there would be no chance of reinfestation from them. The records therefore indicate that the life cycle is at least three years. Borings are still coming out of the wood so the probabilities are that it is longer.

Methods of control for the carpenter worm in the West have been recommended by several writers. Doten (Nev. Agric. Exp. Sta. Bul. 49, pp. 11,12) recommends cutting down and destroying all wormy willows, poplars, cottonwoods and badly infested elms to save the bet-

ter elms. Slightly or moderately infested elms are to be treated by cutting out and probing for the smaller larvae, probing for larger ones and injecting carbon bisulphide in the mines of those that can not be reached by the former methods. Doane (Jour. Econ. Ent., Vol. 5, p. 348) recommends the carbon bisulphide injectment treatment. Childs (Month. Bul. Calif. State Com. Hort. Vol. 111, p. 264) also recommends the bisulphide treatment and the removal of unimportant trees which harbor the pest.

The above mentioned methods are undoubtedly good and when carefully and patiently applied will bring success. It is doubtful, however, if the average gardener or arboriculturist can follow up a heavy infestation thoroughly enough to stop it. From a single elm stump about twelve inches high and eighteen inches in diameter left in control work the writer took twenty-six larvae which varied from one inch to two and a quarter inches in length and which appeared to belong to at least four generations. Following up each mine of such a heavy infestation in a large tree and either catching the worm or killing it by fumigation is very tedious and takes considerable time and skill which makes it expensive.

There is one splendid live oak in Los Gatos which is worth easily $1500.00 to the property on which it stands. It is four feet in diameter, had a main trunk height of about twelve feet, a total height of fifty-five feet and a spread of sixty feet. The foliage is in almost perfect condition but the main trunk and the bases of the larger branches are much scarred by the work of the carpenter worm. During the past ten years the owner has spent about five hundred dollars for protection, yet the tree is still infested with several generations of worms.

The work of the insect was noticed first in this tree about ten years ago. The trunk was heavily infested so a tree surgeon was employed. He went carefully over it, cut off most of the bark and so far as can be determined did a very thorough job. For about four or five years afterwards the tree appeared to be in very good condition and no insect work was noticed. The trunk then became infested again and the regular gardener was put to work on it. He consulted all of the authorities he could find and was given the standard recommendations. These he very faithfully tried to carry out but the tree still showed signs of infestation so last spring he went over the trunk again, cutting out worms and injecting carbon bisulphide and to complete the job gave it a heavy coat of white wash and sprayed it during the first of July with strong kerosene emulsion. The white wash made the over-

looked old infestation and the new infestation much easier to locate, but neither it nor the emulsion prevented egglaying or injured the eggs after they were laid as there is considerable new brood in the bark at the present time.

Cutting into the bark after the worms appears to make the tree more attractive to the female when she is looking for a place for her eggs. The usual control therefore, while it may destroy all of the infesting larvae, is apt to leave the tree in a specially attractive condition for succeeding generations. To overcome this difficulty, to reduce the cost and to give better control for valuable trees, a new method has been suggested by the writers experience with the cage mentioned in the first part of this article.

Such a "knock down" cage with a light wooden frame work, galvanized wire screen walls with a door in one side and a burlap or canvas top can be built for the average California tree at a total cost of about $25.00. It should be put up about May 1st and kept up until the last of July. It will catch all of the moths that emerge from within and will prevent the egglaying of those from without. As long as the tree is infested and the moths emerge some one should visit the tree at least once a day to catch and kill those that have emerged. As they are moderately large and usually fly to the screen and remain quiet they are easily seen and captured.

Our records indicate that even where a tree is heavily infested it is not often that males and females emerge the same day and that when they do the males either are not sexually mature or at least are not attracted to the females from their own tree. There is thus practically no danger of reinfestation from within if the moths are taken once a day.

As a tree that has been infested once remains attractive for some time it should be caged every year for several years after all moths have emerged from the trunk. Once a cage has been built it will last for a number of years and might as well be used to protect the tree until it wears out. The cost of putting it up, taking it down and caring for it will be far smaller than the cost of any other method now known for the control of a heavy infestation of the carpenter worm in large valuable trees.

## Scientific Notes

**Pear Midge.** On examining a number of pear trees in Ithaca, N. Y., I found a heavy infestation of the pear midge (*Contarinia pyrivora*). In one tree where there was promise of a good crop the loss appears to be total. Some of the pears are turning a rusty color while others have completely dried up. As many as thirty larvae, and even more, may be found in a small pear not more than two-fifths of an inch long. Some of these larvae reached maturity, by May 18 and were dropping to the ground.

JOHN D. DETWILER

**A New Almond Aphid.** A severe attack of a species of aphid new to the almond has appeared throughout the Sacramento Valley, California. The species was identified by professor Essig as *Rhopalosiphum nymphææ* Linn., this being apparently the first recorded attack of this aphid on almond although it is frequently found on plums. Liquid applications of nicotine sulphate, 1 in 1000 plus sufficient soap to give a "sudsy" effect have proven superior to nicotine dusts 2% strength. The latter was effective when applied in quantity to the body of the aphid, but indirect applications, resulting from the dust drifting in the wind, were ineffective.

E. R. de ONG
*University of California*

**Camphor Scale in New Orleans.** At a meeting of the Louisiana Entomological Society in April Mr. E. R. Barber, of the U. S. Bureau of Entomology, made a talk on a newly introduced scale insect, *Psudaonidia duplex*, which he reported as killing camphor trees in a limited area in New Orleans. Resolutions were adopted by the Society calling the attention of the city and state authorities to this matter, and reports of the action taken were furnished to the daily papers. Some publicity was secured, and Mr. Barber was afterwards asked to make talks on the scale at meetings of various local secieties. The Bureau later sent Mr. Harold Morrison to look over the situation, and he submitted a detailed report in which he recommended taking steps to control the scale wherever it is established. At Mr. Barber's suggestion, backed by the Association of Commerce and the Horticultural Society, the City Commission Council of New Orleans has voted $5,000 toward control work, with a promise of as much more money as may be needed to carry on the work till funds from other sources have been secured. Badly infested trees are being cut down by the City Parking Commission, and the Bureau is sending a spraying expert to take charge of the work. In the meantime Mr. Barber has been studying the scale, and has taken it on upwards of 100 plants. Camphor seems to be the favorite host plant, but *Ligustrum*, rose, *Citrus*, fig and sweet olive are also injured.

T. E. HOLLOWAY
*Secretary-Treasurer, Louisiana Entomological Society*

**Cotton Boll Weevils.** During the past March and April the writer had an opportunity to investigate cotton conditions on the West Coast of Mexico from Hermosillo south as far as Villa Union, near Mazatlan. Realizing that among the many specimens of boll weevils collected from wild and cultivated cotton there were typical *grandis*, typical *thurberiae*, hybrids and races of various kinds the writer selected a

series of 31 specimens and consulted with Dr. W. Dwight Pierce, in regard to the taxonomy. Dr. Pierce, has examined the series and his determinations are incorporated in the following brief records:

Hermosillo, Sonora, typical *thurberiae* 1 male and 3 females, from cultivated cotton source of infestation probably wild cotton; Colcorit, Sonora, race near *grandis* with dense pubesence, tooth on middle femora tending toward *thurberiae*, 3 males and 1 female, from wild cotton; Cejame, Sonora, 6 males, 1 female, all typical *thurberiae*, from wild and cultivated cotton; Constancia, Sinaloa, 1 male typical *grandis*, 1 female *grandis* tending toward *thurberiae*, 1 female and 1 male very near to typical *thurberiae* all from cultivated cotton, source of infestation probably wild cotton; Los Mochis, Sinaloa, 1 typical *Grandis*, from wild cotton: Navalota, Sinaloa (near Culiacan) typical *grandis*, 2 females and 2 males, from cultivated cotton; Villa Union, Sinaloa, 1 male and 1 female typical *thurberiae*, 3 females and 3 males near to typical *grandis* but all apparently hybrids, from cultivated cotton.

It is interesting to note that conditions in regard to handling of seed cotton and sources of seed for planting purposes were such that both hybrids and typical forms were more likely to occur at Villa Union than at any of the other localities named. Active adults of both typical, arietal and intermediate or hybrid forms were found in large numbers on cultivated cotton at this point. Bolls appeared to be greatly preferred to squares for egg deposition, a characteristic of the variety *thurberiae*.

A. W. MORRILL

**An Early Record Regarding Bot Flies.** Until recently little or nothing was known of the manner by which oestrid larvae reached the interior of their hosts. For Hypoderma bovis and H. *lineata* this has been demonstrated by Hadwen and others.

Not long ago an interesting reference relating to oestrids was found while consulting some old literature. It consists of a communication written by a Dr. Hamlin of Greene County, N. Y., and appeared in Volume VI of the Medical Repository (1808). The section pertaining to penetration of the larvae follows.

"The next difficulty that presented, was to ascertain how the bot insinuated itself into the bowels of the horse. I found the horse frequently to bite and rub the part in the vicinity of those nits, which led me to believe that he swallowed some of them with his food, and they produced the bot after being in the stomach; but the observations that I have since made, lead me strongly to suspect that I was mistaken in that particular; for on separating the hair in the vicinity of those nits, and viewing the skin minutely, I could discover these insects with the naked eye; and on taking a look through a magnifier could see a great number of them; and they appeared to be insinuating themselves into the texture of the horse, through the pores of the skin. I must leave it to more able naturalists to determine the reasonability of the above conjecture; but it is a fact that some had so far penetrated into the skin as to be almost out of sight."

It would seem that the species under mention was *Gastrophilus intestinalis*, though the consensus of opinion supports the ingestion method. However, the writer, though he apparently had no knowledge of entomology, nor access to bibliography such as Clark, specifically mentioned the species as being a bot fly. There is also a chance that the insect belonged to the genus *Hypoderma*, members of which Dr. Ransom informs me infest the horse, though not nearly as commonly as *Gastrophilus intestinalis*. The communication is of interest, since it records actual penetration of larvae, an observation which does not seem to have been noted again for more than a century.

W. A. HOFFMAN
*Albany, N. Y.*

## THIRTY-FOURTH ANNUAL MEETING, AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The meeting will be held at Toronto, Canada, Thursday, December 29, to Saturday, December 31, inclusive.

On Friday, a joint session will be arranged with Entomological Society of Ontario.

The Entomological Society of America will meet on Tuesday and Wednesday of the same week.

Hotel headquarters have been selected at the Prince George Hotel, where the following rates have been secured:

(On the European Plan)

One person to a room, without bath, \$2.50 and up.
Two persons to a room, without bath, \$5.00 and up.

One person to a room, with bath, \$3.50 and up.
Two persons to a room, with bath, \$6.00 and up.

Hotel accomodations are limited in Toronto, and it will be necessary for members to engage reservations early.

It will add greatly to the success of the meeting if members will make reservations at once.

A. F. Burgess, *Secretary*

# JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1921

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations as far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—Eds.

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The need of natural or biological methods for the control of recently introduced pests is emphasized by recent developments in the case of the European corn borer and the conditions in the territory infested by the Japanese beetle. Both of these insects are not easily checked by the more customary repressive measures. Both are spreading and each is a real menace to valuable crops. The history of other introduced insects indicates a period of severe, usually somewhat local injury followed by a more or less gradual reduction in the number of the pests as a consequence of parasite attack, fungous infection or a failure on the part of the insect to continue to respond favorably to climate or other conditions. The relation of an insect to its environment is an exceedingly complex problem and it is practically impossible to forecast the factor or factors destined to bring about a more satisfactory condition. Direct or artificial methods of control should be regarded as somewhat temporary expedients, pending the discovery of more satisfactory ways of dealing with the situation. This is especially true of the field and forest crops where low values prohibit the adoption of systematic spraying or other treatments so common in orchards and it is by no means impossible that the costly schedule of the fruit grower may not eventually be replaced by methods more in harmony with the natural plan of "live and let live," except that there will always be a tendency to turn such forces to man's advantage and it is certainly advisable to avoid, so far as practicable, conditions favorable to injurious insects. This last may have much greater significance than most realize and the possibilities along this line have by no means been exhausted.

## MR. N. V. KURDIUMOFF, RUSSIAN ENTOMOLOGIST DIED 1917.

By Dr. D. Borodin

### In Memoriam

From correspondence which I have had with American entomologists since I arrived in this country, I see that the name of N. V. Kurdiumoff is well known here, but that many do not know about his tragic death. I therefore take the liberty, as one who knew him well and who had been working in the same city with him, to make a brief statement of his life and work.

N. V. Kurdiumoff was born in 1882 in the Kursk district. After graduating from the High School there, he entered the Polytechnical Institute of Kief, studying in the College of Agriculture, and receiving his degree.

The liberal political movement which at that time absorbed the best ranks of the Russian students captivated him, and he was often heard as a brilliant speaker and a determined enemy of the old regime.

His yearning for knowledge and desire for improvement impelled him to leave Russia in 1911, when he came to America and worked under the guidance of Doctor Howard in the Bureau of Entomology, visiting also a number of field stations, notably the one under the direction of Dr. W. D. Hunter in Texas. He returned to Russia, filled with the aspiration to apply all the knowledge acquired in the United States under the guidance of his teacher, Doctor Howard, who is famous throughout the whole world.

After his return to Russia, he organized a Department of Entomology on the plan of similar institutions in the United States, selecting as his station the oldest Russian Agricultural Experiment Station at Poltava, famous for the early research work of Metchnikoff. He founded a great library, in which were collected the principal entomological works of America and Europe.

He worked indefatigably and did not lose contact with the United States. He studied the life histories of several new and very little-known injurious insects, and published a number of works which have become standards of Russian investigations, applying at the same time the methods invented by the bright American school to the Russian territory.

Having specialized under Doctor Howard's direction in the study of the Chalcidoidea, he described certain new species of this group, as well as certain species of thrips.

Dissatisfied with the inaccurate data concerning the amount of injury caused by different species, he drew attention to the necessity of an exact investigation of this subject. He made one reflect seriously upon different phenomena which had previously been admitted as unnecessary of further verification.

In his writings, and also at the congresses of entomologists in Russia, he demanded that an exact investigation be made of the full life histories of different species, and accurate studies as well of their injurious influence upon plants. He demanded the establishment of certain laws of phenomena, following the example of similar work in the United States, since he was always a promoter of American methods in Russian investigations.

With his great desire for knowledge, he went in 1913 to Sweden and England in search of detailed information as to what had been done with *Oscinis frit L.*, in which he was especially interested at that time.

The world war found him at the highest point of his investigations of *Chaetocnema aridula* Gyll., an enemy of wheat. Always a determined enemy of German imperialism and militarism, he entered the Russian army as a volunteer at the same period as did the writer. He started as a simple soldier, took part in several serious engagements and received the highest reward for bravery, the Cross of St. George of the first class.

During his short furloughs from the active army, Kurdiumoff always visited the Poltava Station; in fact, I saw him there for the last time in November, 1915, when I was wounded and had been sent there to recuperate. I had been making some observations upon *Diplosis tritici* Kirby, and he identified the parasites I had reared.

His interest in entomology was overwhelming, and he spent hours at the binocular while in uniform. During the later years of the war, when he had become a lieutenant of artillery, he was engaged in defending the banks of the Dvina river, near Kreisburg.

The news of the revolution in February, 1917, reached him on this front, and he greeted the event with enthusiasm. He could not endure, however, the breaking up of the army which followed the revolution, and among the wire entanglements and the guns deserted by his soldiers in front of the German fortifications, he committed suicide in the autumn of 1917, leaving a series of letters written to his friends.

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## Reviews

**The Crane Flies of New York, Part II, Biology and Phylogeny** by CHARLES PAUL ALEXANDER, Cornell University Agricultural Experiment Station, Memoir 38, p. 691–1133, 539 figs., 1920.

This is a most worthy continuation of the Crane Flies of New York, Part I, dealing with the distribution and taxonomy of the adult flies and appearing as Memoir 25. The author, in this latest contribution, presents a well balanced account of the biology and phylogeny of this large group based upon a study of the immature stages and as an outcome of his studies extending over a number of years, we have very suggestive data respecting all the important tribes and subtribes and most of the genera. The author places the Crane Flies in four families, namely, Tanyderidae, Ptychopteridae, Rhyphidae and Tipulidae, the last being divided into 19 subtribes. There are keys for both larvae and pupae to the subdivisions and most genera as well as most careful descriptions, many original, of the immature stages and detailed biological notes. The author is to be congratulated upon having made such material additions to our knowledge of this group.

Copies of this Memoir will be sent to those interested in this field of research as long as the supply lasts. Address requests to Office of Publication, College of Agriculture, Ithaca, N. Y., and ask for M-38.

E. P. F.

states that President Porras of Panama, in writing to the English sculptor in charge of the work, P. Byrant Baker, has stated, "We appreciate very deeply the sanitary work accomplished by Dr. Gorgas in Panama and feel this is one of the most appropriate ways of showing our gratitude."

Appointments to the Bureau of Entomology have been announced as follows. R. W. Allen, Mexican bean beetle, Birmingham, Ala: E. S. Roberts, Kingsville: Texas: William D. Mecum, Madison, Wis. G. Fletcher, Baton Rouge, La: J. D. Waugh, F. I. Jeffrey, E. G. Small, G. B. Warren. H. L. Weatherby, district inspectors, Mexican bean beetle: C. H. Batchelder, Presque Isle, Me: A. D. Shaftesbury and J. B. Moorman of Johns Hopkins University, experiments in apiculture: John Stuart Pinckney, Clemson College, S. C., to Wichita, Kans., D. M. Dowell, Jr., M. P. Foshee, R. H. Turner, W. P. Whitlock, Mexican bean beetle control: F. M. Hull, Kingsville, Texas, J. W. McGlamery, Florida, sweet potato weevil work; J. I. Hambleton, apriculture, Washington, D. C; H. F. Wickam, Iowa, temporary, to visit Mexico to procure natural enemies of the Mexican bean beetle.

(Additional Appointments U. S. Bureau of Entomology). B. G. Sitton, Ala. State Plant Board, temporarily to Federal Horticultural Board to organize the co-operation of railroad and common carriers in Alabama with respect to the enforcement of Federal Quarantine No. 50; Fred P. Bickley, T. F. Catchings, F. R. White, L. W. Brannon, M. H. Atwood, O. Z. Smith, H. B. Lancaster, District Inspectors; James R. Douglass, Clemson College, research work on Mexican bean beetle in Alabama; W. A. Thomas to investigate truck crop insects in the vicinity of Chadbourn, N. C; Melville Kearney, John W. Couch, Richard H. Flake, Adolph Thomas; boll weevil force, Tallulah, La.

There was held at Geneva, N. Y. on August 4, a conference of phytopathologists and entomologists of the north-eastern apple-growing section, who are especially interested in dusting for the control of injurious insects and plant diseases. The chief feature of the program was the examination of dusting and spraying experiments for the control of the more common pests that attack cabbage, potato, currant and apple. The experiments were projected through the agency of the Crop Protection Institute. Following the inspection of the dusting experiments at North Rose, the representatives from different states reported the principal results of their efforts to date, after which Mr. C. H. Popenoe of the U. S. Bureau of Entomology gave an interesting account of his recent experiences with the Mexican Bean Beetle. The following were present: A. C. Baker, C. H. Popenoe, Washington, D. C.; Anthony Berg, Morgantown, W.Va, T. L. Guyton, Harrisburg, Pa.; R. C. Walton, H. W. Thurston, H. E. Hodgkiss, State College, Pa., Robert Matheson, M. D. Leonard, Ithaca, N. Y., E. M. Stoddard, New Haven, Conn.; P. J. Parrott, Hugh Glasgow, G. F. Macleod and W. O. Gloyer, Geneva, N. Y. The Grasselli Chemical Company, The Tobacco By-Products & Chemical Corporation, Louisville, Ky., The Niagara Sprayer Company, and the Friend Manufacturing Company, also sent representatives.

The Eighth Annual Convention of the New Jersey Mosquito Extermination Association met at Atlantic City April 28 to 30.

About 75 delegates were in attendance at the meeting. Practically all of the salt marsh in Bergen, Hudson, Essex, Union and Monmouth counties has been drained. Considerable drainage remains to be done in Middlesex, Ocean, Atlantic and Cape May, Burlington, Camden, Salem and Cumberland counties.

Dr. J. G. Lipman, Director of the Experiment Station, urged the organization of mosquito extermination commissions in these and other counties not active in mosquito control.

At the present rate of progress, Dr. Thomas J. Headlee, secretary of the association declares it will require 15 years to complete the drainage of all the salt marshes. By raising sufficient funds to undertake the work on a large scale, however, it is estimated that the work can be completed in three years. It is believed that a state appropriation of $250,000 a year for 3 years, or a total of $750,000 would be sufficient to finish the job. This may seem like a large amount of money but is is believed that it would be one of the best investments the state could make. Dr. Headlee estimates that an increase in the valuation of taxable properties of $500,000,000 within a period of 30 years would follow the eradication of the mosquito.

The officers of the association elected for the ensuing year are: President, Charles Lee Myers, Jersey City; Vice-President, Wilfred A. Manchee, Newark; Second Vice-President, Joseph Camp Pierces; Secretary, Thomas J. Headlee, New Brunswick; Assistant Secretary, Wilber Walden, New Brunswick, and Treasurer, Lewis W. Jackson, Jersey City; Executive Committee, Robert F. Engle, Beach Haven; Walter R. Hudson, Paterson; Andrew J. Rider, Hammonton; Ralph Hunt, East Orange; Reid Howell, Rutherford; W. H. Randolph, Rahway, and William Edgar Darnall, Atlantic City.

## Entomologists of Northeastern United States and Canada.

The summer meeting was held at Boston on July 20th and 21st. The first day was given over to:

(1) The inspection of the large cyanide fumigation plant of the Vacuum Company of Somerville, Mass., in the course of which the process of fumigating cotton was illustrated;

(2) The examination of the results of the work and of the control of the satin moth;

(3) Examination of the work of the European corn borer on sweet corn primarily;

(4) Visit to the gipsy moth parasite laboratory where the process of rearing natural enemies could be seen and many of the operations observed.

The evening was spent at Bass Point, Massachusetts and after dinner a regular program was taken up.

Before the regular program Chairman Britton introduced the Assistant Secretary of Agriculture, Dr. E. D. Ball, who had recently been made Budget Officer of the U. S. Department of Agriculture. He asked Dr. Ball to give to the members present such a message as he thought fitting. Dr. Ball said among other things, "That the U. S. Department of Agriculture proposes that its scientific men shall be encouraged to take leave of absence for graduate courses of such a character as will be

accepted for credit in the Universities. Dr. Ball pointed out that the work of General Dawes was not likely in any way to interfere with the progress of the Department but rather would tend to make it a stronger and a better Department of Agriculture.

Chairman Britton then requested Mr. Burgess to make an announcement, and Mr. Burgess reported that the sum of $300.00 was now ready for distribution among the members who had loaned $25.00 each. The distribution of the sum was effected by lot.

The Chairman then called on Mr. Burgess to present "The Present Status of the Gipsy and Brown Tail Moths". Mr. Burgess reviewed the conditions in New Jersey, Pennsylvania, New York and New England. He said in part that there was no stripping in the New Jersey area and that caterpillars were extremely scarce as the end of the season approached. The same condition obtained in the Pennsylvania and New York infested areas. There was more stripping in the New England area than formerly. This condition he believed to be due to the absence of natural enemies. Parasites that did most of the work belong to the species that develop late. He pointed out that the brown tail moth had decreased from an area of 35,000 square miles to 20,000 square miles. This year the insect seemed to have greatly increased. There was a less marked increase in 1920. This year there have been some heavy flights at Portsmouth and Dover, N. H.

Mr. C. H. Hadley requesetd information on the actual damage done by defoliation particularly of deciduous trees. Mr. Burgess replied that much data had been collected relative to this situation but had not as yet been summarized He said that three strippings in consecutive years usually kills ordinary deciduous trees.

Mr. Crosby wanted to know the cause of increase of the brown tail moth. Mr. Burgess said the increase was due he thought to neglect of measures of control and to a less effective low temperature.

The Chairman then called for Mr. Caffrey's paper on recent developments in the life history of the European corn borer. Mr. Caffrey indicated that existence of two broods in New England and only one outside might be due to different strains of the insect. He showed that adults do not distribute ordinarily on winds of any character. Local work against the insect in many cases seems to be quite effective. Water drift of infested material seems to be largely responsible for local increases in area. Larvae can stand total submergence in fresh or salt water for 36 days. The insect has proven much more resistent when dormant. Extremely early planted sweet corn is badly infested. The next planting normally escapes and late plantings of early varieties are usually badly infested. Late varieties are badly injured. A large percentage of the borers are destroyed by plowing under. Removal and burning of infested material is still more effective. Spring plowing has proven useless. Egg parasites are effective on occasion. Introduced parasites have been distributed but there are no results as yet.

The Chairman then called on Mr. Worthley to present his discussion on "Field Methods of Controlling the European Corn Borer". Mr. Worthley said that field control on a large scale had not yet had a test because funds had not been sufficiently continuous. He believed that a large and complete test covering a period of years

should be made. An area of 5 square miles was treated in New York, but the data from that work was not yet available. Quarantine seems to have given practical results. The restrictions proposed in the quarantine have proven practicable.

Chairman Britton then called on Mr. Burgess to give an account of the satin moth. Mr. Burgess stated that the gipsy moth parasites are also attacking the satin moth. This moth is not considered a serious pest in Europe. Effort is being made to prevent the insect escaping from its present area of distribution.

The Committee on Nominations, appointed at the beginning of the session, recommended Thomas J. Headlee, as Chairman and S. S. Crossman as Secretary. These officers were elected and instructed to call the next summer meeting at the place and time decided upon by them.

The next day was given over to an examination of the large scale work against the gipsy moth. Stripped areas which were refoliating were examined. Deciduous trees that had died under successive defoliation were seen and the operation of a large gipsy moth sprayer was demonstrated.

The following men attended the meetings:
Edward Anderson, J. T. Ashworth, E. D. Ball, George Barber, W. E. Biitton K. E. Buffington, A. F. Burgess, H. N. Butler, D. J. Caffery, W. P. Colvin, D. G., Craig, C. R. Crosby, S. S. Crossman, S. M. Dohanian, W. O. Ellis, R. C. Ellis, E. P. Felt, E. L. Fitzhenry, H. L. Frost, P. Garman, F. W. Garver, M. Guptill, C. H. Hadley, J. E. Halbrook, T. J. Headlee, B. E. Hodgson, J. L. Horsfall, D. J. Jones, D. W. Jones, F. V. Learoyd, M. D. Leonard, C. N. Lewis, P. R. Lowry, H. U. Manchester, H. L. McIntyre, C. A. McIsaac, D. G. Memphing, James Moloy, H. Morson, F. J. Mosher, W. C. O'Kane, H. L. Parker, P. J. Parrott, Alvah Peterson, Saul Phillips, B. A. Porter, T. R. Richardson, D. M. Rogers, F. W. Rosse, L. M. Scott, J. V. Shaffner, Jr., M. T. Sherman, George Smith, G. A. Smith, R. I. Smith, M. T. Smulyan, J. N. Summers, C. L. Towler, R. A. Vickery, F. Viddler, B. H. Walden, R. W. Walton, R. W. Wooldridge, L. H. Worthley, M. P. Zappe.

THOMAS J. HEADLEE, *Secretary*

**Applied Entomology, An Introductory Text-book of Insects in Their Relation to Man** by H. T. FERNALD, pp. i–xiv, 1–386, 388 figs., McGraw-Hill Book Company, Inc., New York, 1921.

The author admirably describes this latest addition to entomological literature as "a classroom text for an introductory course * * * which shall give a general idea of insects, their structure, life histories and habits, with methods for the control of insect pests in general, followed by a more thorough study of the more important ones found in the country." It is primarily a textbook concerned first in placing insects in relation to the animal kingdom, in defining their general characters and explaining both the external and internal structure. Then comes an outline of the development of insects, a discussion of the losses caused by these pests, and four excellent chapters on control methods and materials used therefor, namely insecticides.

The author recognizes more orders than most writers on applied entomology. The treatment is primarily taxonomic and in the discussion of each group one finds an estimate of its economic importance. Concise accounts are given of the more injurious species in each order, those relating to insects of general distribution being in large type while the more local or minor pests are treated of in small type.

The problems of proportion and selection incident to the production of such a work have been solved in a very satisfactory manner. The long series of illustrations have been drawn from many sources, some from European works and not a few being original; in general, they are the best extant. There has been similar selection of subject matter and a high standard unusually comprehensive textbook produced. Both author and publisher are to be congratulated.

E. P. F.

## Current Notes.

The summer meeting of the Michigan State Beekeepers' Association was planned to be held at Alpena, August 3 – 4.

Dr. W. E. Britton, State Entomologist of Connecticut gave an illustrated lecture, June 13, before the New York Florists' Club.

Announcement has been made that the Ohio State Beekeepers' Association would hold a field meeting at Ashtabula, August 20.

The third annual meeting of the Wisconsin State Beekeepers' Association was scheduled to be held at Chippewa Falls, August 15 – 20.

Mr. Leonard S. McLaine, Chief, Division Foreign Pests, Entomological Branch, Canadian Department of Agriculture, has returned from a trip to Europe.

*Science* states that Mr. A. Musgrave, is to fill the vacancy caused by the death of W. J. Rainbow, as Entomologist on the staff of the Australian Museum at Sydney.

Recent transfers in the Bureau of Entomology are as follows:– W. B. Turner, Corn Borer work to Sacramento, Calif; E. M. Searls, Silver Creek, N. Y. to Madison, Wis.

The Connecticut Beekeepers' Association held its summer meeting at Storrs, during Farmers week, August 2 – 5. Dr. E. F. Phillips, and J. E. Crane were among the speakers.

Mr. Frank Hennessey has been appointed artist and photographer of the Entomological Branch, Canadian Department of Agriculture, in place of Mr. Arthur Kellett, resigned.

According to the Experiment Station Record, Rev. C. J. S. Bethune, for fifteen years professor of Entomology at Ontario Agricultural College, has resigned to return to private life.

Dr. Herbert Haviland Field died at Zurich, Switzerland, April 5, 1921, aged 53. He organized at Zurich, in 1895 the Concilium Bibligraphicum which it is understood will be continued.

Mr. W. H. Goodwin formerly an assistant in the Entomological department of the Ohio Agricultural Experiment Station is again helping with the insect work during the summer months.

Mr. W. D. Whitcomb of the U. S. Bureau of Entomology who has been assisting with the curculic work at Fort Valley, Ga., has returned to his permanent station at Yakima, Washington.

A field meeting of the Eastern Massachusetts Society of Beekeepers at Dedham, August 6, was announced. Dr. E. F. Phillips, of the Bureau of Entomology was expected to be the principal speaker.

Mr. R. N. Bissonette, field crop and garden insects, and Mr. F. H. Peck, messenger at headquarters have been appointed temporarily to the Entomological Branch, Canadian Department of Agriculture.

Dr. W. Dwight Pierce, Managing Director Biological Departmet, The Mineral Metal and By– Products Co., formerly of Denver, Colorado, has moved his head quarters to Wisnom Building, San Mateo, California.

Mr. Oliver I. Snapp in charge of the U. S. Peach Insect Laboratory at Fort Valley, Georgia, spent a part of July in the Southern Pine and Pinehurst peach section o North Carolina in connection with curculic control work.

According to *Science*, Indiana University has conferred the degree of Doctor of Laws upon W. S. Blatchley, formerly State Geologist of Indiana and author of "The Coleoptera of Indiana" and the "Orthoptera of Indiana."

Mr. F. C. Bishop of the Dallas (Texas) laboratory of the Bureau of Entomology, i in New York State, where a series of experiments are being conducted in the contro of ox warble among dairy cattle.

# Current Notes

Dr. A. E. Cameron who resigned from the Entomological Branch, Canadian Department of Agriculture, in October 1920, has been re-appointed as temporary entomologist for the present season, and will have charge of a laboratory at Saskatoon, Saskatchewan.

An important meeting of official entomologists of the Federal and Western provincial Governments, Dominion of Canada, was held at Regina, April 12. Mr. Norman Criddle of Treesbank was elected chariman. Representatives were present from Minnesota, Montana and North Dakota.

Prof. Z. P. Metcalf of the North Carolina State College and Experiment Station, was the retiring president of the North Carolina Academy of Science and gave "The Age of Insects" as his presidential address at the recent annual meeting.

Mr. L. S. McLaine, Chief of the Division of Foreign Pests Suppression, Entomological Branch, Canadian Department of Agriculture, sailed from Montreal on May 6, to visit England, France, Holland and Belgium. While there he will visit the larger nurseries and confer with the respective government officials regarding nursery nspection work.

According to *Science*, George M. Wheeler Ph.D. (1921) Bussey Institution, has been appointed instructor in Entomology, and William E. Greenleaf, instructor in Zoology, in the Zoology department, Syracuse University.

Mr. C. H. Brannon, a graduate of the Mississippi Agricultural and Mechanical College has been appointed field assistant in the U. S. Bureau of Entomology for duty at Fort Valley, Georgia, in connection with curculio work.

Resignations from the U. S. Bureau of Entomology, recently announced, are as follows:– C. K. Fisher, Wichita, Kans, to enter the States Relations Service in Virginia; R. H. Van Zwaluwenburg, Hagerstown, Md., to enter commercial Entomology in Mexico.

Mr. John B. Gill of the U. S. Bureau of Entomology has returned to his permanent station at Brownwood, Texas, after spending five months at the U. S. Peach Insect Laboratory, Fort Valley, Ga., assisting with extensive dusting and spraying experiments.

According to *Science*, Professor G. F. Ferris of Leland Stanford University, California, is spending the summer collecting and studying scale insects in Texas, in co-operation with the Division of Entomology of the Texas Agricultural Experiment Station.

Mr. Burl A. Slocum has been appointed Bee Specialist in the State of Washington. His time will be equally divided between the Division of Apiculture under Dr. A. L. Melander, and the Extension Service under Dr. S. B. Nelson. Mr. Slocum is a graduate of the University of Wisconsin in the Beekeeping course.

Professor S. A. Forbes, University of Illinois, and Professor Herbert Osborn, Ohio State University, attended a conference on conservation of resources of interior waters, at Fairport, Iowa, June 8–10. This conference was called by the Secretary of Commerce; Professor Forbes was chairman and Professor Osborn was one of the vice-chairmen.

Dr. L. O. Howard acted as toast-master and Dr. E. D. Ball, was one of the speakers at a farewell dinner at the Cosmos Club, Washington, June 17, given by the bureau chiefs to Dr. Carl L. Alsberg, who has resigned as Chief of the Bureau of Chemistry to become one of three directors of the Food Research Institute, established at Stanford University, by the Carnegie Corporation.

According to the *Entomologists Monthly Magazine*, the following English Entomologists have died during the past year:—Dr. Herbert Henry Corbett, of Doncaster, January 5, 1921, in his 65th year: John William Carter, of Bradford, December 15, 1920 aged 67: and John Clarke Hawkshaw, of Hollycombe, February 12, 1921, in his 80th year; All were interested in the Microlepidoptera and in other orders of insects.

Dr. R. W. Leiby has returned to his position as Assistant Entomologist in investigations for the North Carolina Department of Agriculture and Experiment Station after spending the fall and winter months as a graduate student in Entomology at Cornell University. The Degree of Doctor of Philosophy was conferred upon Mr. Leiby by Cornell at its recent commencement. Dr. Leiby's thesis subject concerned insect Polyembryony.

The Experiment Station Record announces that a new scholarship in Entomology has been awarded by the British Ministry of Agriculture and Fisheries, on recommendation of the Advisory Committee on Agricultural Science with the concurrence of the Development Commission. This scholarship is for 200 pounds, for a term of two years, and is available for study at institutions either in England or abroad, subject to the approval of the Ministry.

The honorary degree of Doctor of Science was conferred upon C. L. Marlatt Assistant Chief of the Federal Bureau of Entomology, and Chairman of the Federal Horticultural Board, by the Kansas State Agricultural College at the 58th annual commencement, June 2nd, in recognition of his contributions to our knowledge of insects and his efficient services in initiating the policies and directing the work of the Federal Horticultural Board.

The new apicultural building of the Ontario Agricultural College was formally opened during the annual convention of the Ontario Beekeepers Association. It is a two-story building of tapestry brick about 65 x 47 feet in size, and cost about $60, 000.00. The lower floor cantains offices, a reading room and a microscopical laboratory, and the second floor has a lecture room seating 250 persons. The basement contains a honey and wax room, and bee cellar with special devices for ventilation and heat control.

According to *Science*, the government of Panama has purchased a bronze bust of the late General William C. Gorgas, which will be placed at the entrance of the Santo Tomas Hospital at Panama. The journal of the American Medical Association

# JOURNAL

OF

# ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 14 OCTOBER, 1921 No. 5

## Proceedings of the Sixth Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The sixth annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held in Room 212, Agricultural Hall, California University, Berkeley, California, August 4-5, 1921.

The first meeting was called to order at 9:00 a. m. August 4, by Chairman E. O. Essig. A brief business session was held at the opening of the session, followed by the presentation of papers; the session closing the afternoon of the fifth with the election of officers and other unfinished business.

The attendance was the largest and probably the most representative of any of our sessions. The symposium idea as attempted in the program met with enthusiastic approval; the discussions were general and lively; the provisions made by the local entomologists for the convenience and entertainment of the association most pleasing; and the meeting in every way a decided success.

### PART I. BUSINESS SESSION

The business meeting was called to order by Chairman E. O. Essig at 9:00 a.m., August 4, 1920. Unfortunately no complete roster of attendance is available. The following were present:

Harry S. Smith, Sacramento, California.
S. B. Doten, Reno, Nevada.
F. B. Headley, Fallen, Nevada.
Geo. A. Coleman, Berkeley, California.
R. D. Hartman, Los Gatos, California.
B. B. Fulton, Corvallis, Oregon.
A. J. Basinger, Berkeley, California.
H. E. Burke, Palo Alto, California.

Edwin C. Van Dyke, Berkeley, California.
A. W. Morrill, Los Angeles, California.
A. L. Lovett, Corvallis, Oregon.
E. O. Essig, Berkeley, California.
Geo. P. Weldon, Ontario, California.
Donald D. Penny, Watsonville, California.
D. B. Mackie, Sacramento, California.
T. D. Urbahns, Sacramento, California.
Stanley S. Freeborn, Berkeley, California.
Cecil W. Creel, Reno, Nevada.
R. W. Doane, Stanford University.
V. M. Tanner, Stanford University.
E. A. Schwing, Salinas, California.
W. G. Hartung, Salinas, California.
F. H. Lathrop, Corvallis, Oregon.
A. O. Larson, Alhambra, California.
E. R. DeOng, Davis, California.
J. W. Hungate, Cheney, Washington.
W. Dwight Pierce, San Mateo, California.
W. W. Thomas, Berkeley, California.
W. B. Herms, Berkeley, California.
A. O. Dahlberg, San Francisco, California.
Roy E. Campbell, Alhambra, California.
Wm. B. Turner, Sacramento, California.
H. J. Quayle, Riverside, California.
Eubanks Carsner, Riverside, California.
C. F. Stahl, Riverside, California.
J. P. Martin, Berkeley, California.
J. M. Miller, North Fork, California.
Henry H. Severin, Berkeley, California.
E. P. Van Duzee, San Francisco, California.
R. E. Smith, Berkeley, California.
R. Rudolph, Mt. View, California.

The following committees were named by the chair:

Nominating: H. S. Smith, Chairman, A. W. Morrill, S. B. Doten.

Membership: R. W. Doane one year, Chairman, E. J. Newcomer, two years, Edwin C. Van Dyke, three years.

Auditing: Stanley S. Freeborn.

The report of the secretary-treasurer was then presented:

## Report of The Secretary-Treasurer

### Financial Statement

| | | | | |
|---|---|---|---|---|
| 1921. | | | | |
| February | 1. | On hand— | | $24.60 |
| March | 18. | Paid Affiliation fee to Amer. Assn. Adv. Sci. | 5.00 | |
| Aug. | 1. | Stamps for mailing programs of Berkeley meeting | .90 | |
| Aug. | 2. | Telegram to President Re. program | 1.66 | |
| | | | $ 7.56 | $24.60 |
| Aug. | 4. | Amount on hand | | 17.04 |
| | | Refund from Amer. Assn. Econ. Ent. Due | | 7.56 |

*Morning Session August 5, 9:00 A. M.*

Chairman E. O. Essig. I am in receipt of a Communication from President Dean of the parent association which I will take the liberty to read.

Manhattan, Kans. Aug. 4, 1921.

E. O. Essig:
University of Calif.
Berkeley Calif.

As President of the American Association of Economic Entomologists I am pleased to extend congratulations and greetings to the Pacific Slope branch of the Association upon the occasion of its sixth annual meeting. Your splendid meetings in the past and the program you have arranged for at this meeting speak well for the enthusiasm, energy and enterprise of its members. I am sure the entire membership of the American Association of Entomologists wishes the members of the Pacific Slope a most pleasant and profitable meeting. Very sincerely yours,

(signed) Geo. A. Dean, *President*

*Afternoon Session August 5*

At the close of the formal presentation of papers the closing business meeting was held. The nominating committee reported as follows:

Report of Nominating Committee

The following were nominated for office during the ensuing year:
For Chairman, A. L. Lovett, Corvallis, Oregon.
For Secretary-Treasurer, E. O. Essig, Berkeley, California.
These were duly elected.

It was moved and carried that a program committee be appointed by the Chairman to act with the chairman and secretary as ex officio in the preparation of next year's program.

Following a discussion of some points regarding nomenclature of our western insect forms it was moved and carried that the Chairman appoint a Nomenclature Committee to pass upon matters of nomenclature for our western forms and submit recommendations to the parent nomenclature committee.

The following Committees were appointed:
Editorial: W. B. Herms, Chairman, H. S. Smith.
Affiliation: R. W. Doane, Chairman, E. C. VanDyke, H. E. Burke.
Program: H. J. Quayle, Chairman, D. B. Mackie, Ralph H. Smith.
Nomenclature: Edwin C. Van Dyke, Chairman, L. P. Rockwood, A. L. Melander. This concluding the session the meeting was declared adjourned until next year.

A. L. Lovett, *Secretary-Treaurer.*

## PART II. PAPERS AND DISCUSSIONS

*Morning Session August 4, 10:00 a.m.*

Chairman E. O. Essig: We will now proceed to the presentation of the formal program of papers. The first is a symposium: Nicotine Dust Sprays and Mechanical Devices in Insect Control[1].

[1]Unfortunately no records were made of the very interesting discussions of the papers given and these are, therefore, not included.

## DUST INSECTICIDES IN CALIFORNIA

By E. O. Essig, *Univ. of California, Berkeley, Calif.*

Recent developments in the use of dust insecticides in California are the outgrowth of some investigations and experiments on the walnut aphis (*Chromaphis juglandicola* Kalt.) by Prof. R. E. Smith, of the Division of Plant Pathology, University of California, begun in 1914. Professor Smith had been doing considerable experimental spraying of walnuts for the control of walnut blight and it was in connection with this disease that aphis control was also undertaken. The desirability of a dust which could be quickly and cheaply applied was apparent, because the well-known nicotine and soap sprays were almost prohibitive on account of the great size of the trees. The first definite results were obtained by impregnating finely pulverized kaolin with "Blackleaf 40". For the walnut aphis a dust composed of 2% "Blackleaf 40" was found to be thoroughly adequate.

Orchard tests were so thoroughly satisfactory during the years following 1916 that a great impetus was given to the study of dusts in general with the results that rapid advance is being made along many new lines.

The development of the so-called nicodust was made by Professor Smith through the California Walnut Growers Spray Manufacturing Company which manufactured the material in large quantities particularly for members of the California Walnut Growers Association, but did not neglect to develop a general trade in the insecticide. The name nicodust originally given the mixture by Professor Smith has become so general that it will probably always be used to designate any dry material treated with a nicotine extract and is so used in most western articles dealing with such materials.

So great has been the interest in this material that it is now prepared by at least four large insecticide manufactureres and the number is increasing rapidly. Various combinations and mixtures of nicodust with sulfur, the arsenic compounds, fungicides, etc. are also appearing in rapid succession until the orchardist is faced with a serious problem in selecting the really efficient and less expensive article. At the present time lime has practically replaced kaolin, because it liberates the volatile nicotine more readily and therefore gives better results.

Many experiments were and are still being conducted by the manufacturers and others to determine the efficiency of nicodust and its various combinations for different insect pests and plant diseases. Professor Smith did considerable along this line, particularly in the control of aphids and the onion thrips.

Mr. R. E. Campbell, Bureau of Entomology, United States Department of Agriculture has summed up a long series of experiments on "Nicotine Sulphate in a Dust Carrier Against Truck Crop Insects" in Circular 154 United States Department of Agriculture issued February 21, 1921.

It occurred to the writer that this material might prove satisfactory as a control for pear thrips and two seasons' experimental work has demonstrated this conclusively as originally stated in Circular No. 223 of the University of California, Agricultural Experiment Station, issued in November 1920.

During the past season there has been a large accumulation of data obtained chiefly by entomologists relative to the different insects which may be controlled by various strengths of nicodust. Among those receiving the most attention may be mentioned:

*Aphids*—Various aphids, excepting those which are protected by a waxy covering like woolly apple aphis and mealy plum louse. The writer conducted a series of experiments on most of the common garden species and found that practically all were easily killed with a 5% or 6% "Blackleaf 40"[1] mixture. Investigations conducted in Sonoma County on the purple or rosy apple aphis (*Aphis malifoliae* Fitch) were very promising and good control was obtained on the infested plots where dusting was begun as the leaf buds opened and continued until the winged aphids began to migrate in from the untreated areas. Experiments covering a period of two years in the melon aphids conducted by various farm advisors and others were reported successful in all cases where a 6% dust was used.

*Grape leafhopper*—Some apparently successful demonstrations on the control of *Erythroneura comes* (Say) were made by at least two different distributors of nicodust in the San Joaquin Valley. These demonstrations indicated that a 6% dust would kill all nymphs, but that it required a 10% dust to destroy the adults.

*Hairy Caterpillars*—From many experiments conducted by the writer and others on such hairy caterpillars as those of the tent caterpillars (*Malacosoma* spp.) brown day moth (*Pseudohazis eglanterina* Boisd.); the fall webworm (*Hyphantria cunea* Drury); the chalcedon butterfly (*Lemonias chalcedon* D. & H.); the thistle butterfly (*Vanessa cardui* Linn.) and the West Coast Lady (*Vanessa caryae* Hubn.) indicate that the young readily succumb to nicodust treatment.

*False Chinch Bug*—During this summer the false chinch bug (*Nysius ericae* Schilling and the small variety *minutus* Uhler) appeared in very

[1]Percentages refer to the quantity of "Blackleaf 40" in all cases.

destructive numbers in many localities in California from Imperial Valley to the central part of the state. In one instance at least it is reported to have been successfully controlled by a 6% nicodust.

### Combinations of Nicodust

There has also been collected a great deal of miscellaneous data on the various combinations of sulfur, arsenic compounds and fungicides on insect control. The use of lime instead of kaolin to produce a more efficient dust by liberating pure nicotine to be further fortified by the addition of dry sulfur at the time of mixing for nicosulfur dusts appears from many experiments conducted under widely different conditions upon various insects, to be more efficacious than nicodust of the same strength without the sulfur. When sulfur alone is treated with "Blackleaf 40" it appears to increase the efficiency of the nicotine over lime alone, but because of its weight it is not as easily handled in the dusting machines as is the regular nicodust.

Mixtures of nicodust and powdered arsenate of lead were very efficient in controlling caterpillars and flea beetles, particularly the latter on tomatoes.

Dusting for the control of the codling moth has received a considerable impetus and a large number of experiments are under way, mostly conducted by orchardists or insecticide manufacturers. We are contemplating a definite series of experiments along this line next year.

The revival of tobacco dust is also to be noticed and many mysterious "kill all" mixtures are being put on the market as rapidly as possible.

In conclusion I feel certain that there is a great future for dust spraying. As yet it has hardly been touched. The development of new machinery is also uncertain. The two must go hand in hand. As entomologists we should take an impartial view and do all in our power to bring about the very best possible conditions for the profitable production of clean and wholesome agricultural products by the elimination of insect pests by the most efficient and economical means.

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## NOTES ON THE USE OF NICOTINE DUSTS

By A. W. Morrill

*Consulting Entomologist*

During the past few months the writer has given considerable time to investigations of nicotine dusts for the California Sprayer Company, manufacturers of a well known dusting machine and of a brand of nicotine insecticides. Work has been done with many species of insects but the

results which I have to offer at this time are for the most part fragmentary. However, it is hoped that the miscellaneous observations here recorded may prove of some value to others.

## Observations on the Use of Nicotine Dusts Against the Grape Leaf-Hoppers

It was found by various investigators in the season of 1920 that the grape leaf-hoppers were susceptible to the effects of nicotine dusts but to what extent these insects were actually killed seems not to have been definitely determined. Reports in regard to the effectiveness of nicotine dusts against the leaf-hoppers became rather conflicting early in the present season and field tests were consequently undertaken in the Imperial Valley and later in the San Joaquin valley to discover the facts in regard to this question.

As a basis for work against the grape leaf-hoppers it was considered necessary to make a study of the methods of checking results of nicotine dust applications in vineyards. The method in common use consisted in spreading papers or canvas under the vines to be dusted and observing the hoppers which dropped on these comparatively smooth surfaces. Other observers modified this method by dumping the dead and stupefied insects from papers or canvas into pasteboard boxes or glass jars together with the dust which had dropped from the vine with the insects. By these methods an element of uncertainty was introduced by the assumption that the dusts which had dropped from the treated vines had lost all toxicity.

Among the methods tested by the writer were: (1) observing hoppers which dropped onto papers and canvas spread under the vines (2) observing hoppers which dropped into an old galvanized bucket with rough bottom (3) observing hoppers picked up with forceps from papers and canvas within five minutes after applying dust to the vines and kept in glass jars or vials (4) observing hoppers which dropped into a galvanized bucket within five minutes from the application of dust to the vine and which were dumped into a wire sifter to separate from dust and then into a glass jar for observation (5) observing hoppers which dropped onto a fine wire screen (about 50 mesh) through which most of the dust immediately passed and (6) observing hoppers which were left lying as they fell on the ground under the vines.

The last mentioned method was the most tedious but was necessarily the standard. The use of a fine wire screen (the inverted top of an insect breeding cage was used in this observation) appeared to give results which approximated those obtained by the standard method and the

insects were much easier to locate and keep under observation. When the insects dropped onto papers spread on the ground even a slight breeze had a tendency to blow the insects and dust together in depressions giving far from normal conditions. One would naturally suppose that by carefully picking up adults which had fallen onto canvas and dropping these into glass jars the insects would be under conditions as favorable for recovery as though they were lying on the ground under the plant. This however, does not appear to be the case. When collected in a bucket placed under the dusted plant and the dust sifted from the mass of insects a very noticeable difference in the percentage of recovery was noted in tests with different lots of dust. It has not been determined whether this is entirely due to a difference in toxicity or is partly due to other factors, such as air movement affecting the amount of dust adhering to the insects.

In order to determine whether field results from different lots of dust corresponded with the nicotine content two sample dusts which apparently were of low toxicity were analysed[1] for comparison with two other lots of similar dusts of apparently high toxicity. The analyses and field results are shown in the following table:

| Lot no. | 1 | 2 | 3 | 4 | aver. 1&2 | aver. 3&4 |
|---|---|---|---|---|---|---|
| Percentage adult leaf hoppers recovered | 14.3 | 25. | 1.5 | 0 | 19.6 | .72 |
| Nicotine shown by analysis of sample | 1.95 | 1.76 | 1.30 | 1.25 | 1.85 | 1.27 |

Field tests of lots 2, 3 and 4 were made on June 16 in the same vineyard near Fresno within a period of 1 hour, using exactly the same methods. All conditions were supposedly practically identical. The test of lot 1 was made in another vineyard on the preceding day. No difference was noted in temperature or wind conditions which could account for the difference in killing effects as compared with the other three samples. In these tests the insects dropped into a bucket and were separated from the dust by means of a sieve, then kept in closed Mason jars for observations.

In another field test using a nicotine dust which analysed 2.23% nicotine the field tests showed results strikingly inferior to those with a dust of exactly the same composition but with only 1.55% nicotine. These tests were made near Holtville in the Imperial Valley, one application immediately following the other and all conditions supposedly practically identical. The insects were collected on canvas spread under the vines, picked up carefully with forceps and kept in vials for observation. Eleven

[1]Analyses made through cooperation of Prof. Gray, Chief Div. of Chemistry, Cal. Dept of Agric.

out of 40 adults recovered within two hours in case of the vine dusted with the 2.23 dust whereas with the 1.55% dust only one adult out of 75 under observation recovered during a period of 7 hours.

No conclusions should be drawn from the foregoing observations except to the effect that either the nicotine content does not necessarily indicate the relative toxicity of nicotine dusts of otherwise practically identical chemical composition or that the methods described for securing the results are of very questionable dependability.

As already noted the standard method of checking results of dust applications consists in observing the insects on the ground under the treated plant. On June 18, Mr. A. J. Flebut of the U. S. Bureau of Entomology, and the writer undertook to determine the difference in the percentage of recovery of adult leaf-hoppers left on the ground under dusted vines, on screens and in buckets. Of 109 adults under observation 56 were in buckets and none of these recovered, 40 were on fine wire screens and of these 28 recovered while 13 were on the ground where they fell from the vines and of these 11 recovered. Of 21 nymphs under observation in the same tests, all on the screens, 7 recovered. These figures do not necessarily indicate the value of dusting for the leaf-hoppers since many of the insects, both nymphs and adults, drop onto the upper surfaces of leaves where they remain in contact with dust and apparently are under as unfavorable conditions as the adults which were under observation in the bucket. Furthermore many or most of the nymphs which recover on the ground probably fail to get back on to the plants. This probably explains the reason why satisfactory results were reported by many vineyard owners who used the dusting method early in the season. In the tests above mentioned dusts were used in which 7½% and 10% of Blackleaf 40 were used in manufacture, the analysis showing 2.4 and 3.8% of nicotine respectively; the former with 90% hydrated lime and 10% sulphur as a carrier and the latter with a carrier composed of approximately 75% sulphur and 25% lime.

From the writers observation it appears that the use of ordinary nicotine dusts against the grape leaf-hopper is of little value against the adults.

Against the nymphs the value appears to consist in stupefying a large percentage causing them to drop. Early in the season before the vines have runners lying on the ground or in the case of trellised vines, this probably is equivalent to killing a large percentage of the insects.

In certain experiments in which a second application of dust was made to vines from one to 24 hours after the first, it was estimated that the first application caused 100 per cent of the nymphs to drop in the first

experiment, 95% in the second, and 95.2% in the third. The number of nymphs counted in the three experiments was 46, 106, and 681 respectively. The foregoing tests were somewhat less dependable in the case of the adults since some of those which did not drop from the first application may have left the plants. In one test however in which a square block of 16 vines was dusted, a second thorough dusting 24 hours after the first showed that about 55% of the adults had been killed or had disappeared from the central block of four vines. Nine hundred and seventy-four adults were included in this count. Only those which dropped from each vine into a bucket within five minutes after the dust was applied were included, the estimated total for the average plant being about 1700.

## Observations on the Use of Nicotine Dusts Against the Melon Aphis

Investigations of the writer in the Imperial valley and other points in Southern California have not developed much of practical value to add to the discussion of melon aphis control presented by Mr. Roy Campbell in Circular 154 of the U. S. Dept. of Agriculture. For scattering infestations the writer advises nicotine dusts with not less than 2.4% nicotine. This requires about 7½% of Blackleaf 40 in manufacture. The expense in this case is partly for insurance of the uninfested plants against the spread of the insects. When the infestation is general throughout the field and the problem has become one of reasonable control for the purpose of maturing a marketable crop, with no consideration for restriction of spread, a dust with about 1.5% of nicotine, or 4 or 5% Blackleaf 40 used in manufacture, is to be preferred.

The need of early season scouting or patrolling of the melon fields to locate incipient aphis colonies cannot be too strongly emphasized. Paradoxical as it may seem, the most expensive treatment on a basis of cost per hill is the most economical. Growers can better afford to spend $4.00 a day for patrolling in early season when a man can find only one or two infested plants each day, at a cost of two to four dollars per hill for labor alone, than he can afford 5c a hill for both labor and material in dealing with a general infestation when the melons are beginning to mature. If a commercial melon field were so generally infested throughout as to require treatment of all the vines with an insecticide to save the crop, the cost of dusting would be prohibitive. Such a condition seldom if ever occurs however, since ordinarily by the time such a widespread infestation has developed a large percentage of the plants are already dead.

An attempt was made to overcome the interference of high winds and to reduce the amount of material needed per plant by using a canvas cover to confine the dust. Areas about three feet square were covered with eight ounce duck held 2 to 4 inches above the leaves of the vines and with side pieces extending to the ground. From one-fifth to one-fourth of the amount of dust normally required was used per plant, discharging the dust at different parts of the enclosure in different tests. These results did not encourage the belief that the use of covers could be used to advantage with the dusting process.

In the Imperial Valley late in May and early in June, with maximum daily temperatures ranging between 93 degrees and 103 degrees, nicotine dusts containing approximately 75% sublimed sulphur caused burning of canteloupe plants.

A single infested watermelon plant treated with such a dust May 29th showed no injury, the aphids being completely eradicated. Pure sulphur applied as a check to canteloupe plants on June 1 had caused no noticeable damage two days later but on June 5 it was noted that the dusted vines were badly burned. While nicotine sulphur dusts may not cause any damage to canteloupes where the temperatures are more moderate than in the Imperial Valley it appears safer to avoid the use of dusts on this crop containing more than 10% sulphur.

Special mention should be made of the relation between nicotine dusts for the melon aphis and the natural enemies of this pest. During the period mentioned above, adult lady bugs were very abundant in the melon fields but there were very few eggs and larvae present. Hymenopterous parasites were remarkably scarce. The most active natural enemy was a species of syrphus fly. A similar situation with regard to melon aphis natural enemies was noted at Burbank near Los Angeles, during July. The adults and larvae of lady birds (*Hippodamia convergens*) and the larvae of the syrphus flies (species unknown) were apparently uneffected by the nicotine dusts used in the experiments.

In tests of nicotine dusts against the melon aphis near Los Mochis, Sinaloa, Mexico in March 1921 it was noted that the adults of hymenopterous parasites (*Aphidius testaceipes*) were apparently not affected by dusts which were satisfactory against the aphis. The aphids which survived the dust, located mostly in curled leaves, received the concentrated attack of the parasites resulting in almost complete eradication of the pests.

### Observation on Nicotine Dusts Against The Woolly Apple Aphis

Prof. P. J. Parrott has reported[1] nicotine dusts as strikingly ineffective against the woolly apple aphis in his experiments. This is as would be expected but for some reason the writers preliminary tests have shown remarkable susceptibility of this species to nicotine sulphur dusts averaging about 1.6% nicotine[2] and somewhat less susceptibility to a dust containing over 2% nicotine with a carrier composed of 90% lime. Although only a few infested trees have been available for this work, repeated applications have given uniformly good results. The writer has had experience in the use of nicotine soap solutions against the woolly aphis but in the preliminary dusting experiments here referred to, obtained better results with less effort than previously with the wet applications.

Using the dusts mentioned above colonies of the aphids were frequently completely eradicated on small trees with dust blown from a distance of three or four feet with not enough air pressure to disarrange the waxy covering of the insects and with so little dust remaining attached to the wax as to be scarcely noticeable to the naked eye. The difference in the results obtained by Professor Parrott and the writer may be due to the difference in nicotine content of the dusts tested or perhaps to the dusting machine used by the writer being better adapted for the work. The applications here recorded were made with temperatures ranging from 75 to 85 degrees but no relation between the temperatures and the results was noted.

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## TWO MECHANICAL DEVICES FOR CONTROLLING WESTERN CUCUMBER BEETLES

By Roy E. Campbell, *Assistant Entomologist*, and Walter H. Nixon[3]

In the State of California the western twelve-spotted cucumber beetle (*Diabrotica soror* Lec.) known locally as well as somewhat generally as *the* "Diabrotica," and erroneously as the "green ladybird", causes considerable damge each year.

The beetle is a very voracious and universal feeder, the number of its food plants being placed at over five hundred. From a commercial standpoint, the injury is confined mostly to crops such as beans, cucumber, alfalfa, beets, pumpkin and melons. The injury of cucurbits is to the stems and leaves of the young plants; of alfalfa and beets it is to the

[1]Jour. Econ. Ent. Vol. 14, p. 211.
[2]The writers statements of nicotine content refers to the results of analyses of the manufactured dust and not to the amount of nicotine added to the carrier.
[3]Assistant Superintendent, Trial Grounds, C. C. Morse & Co., San Carlos, Cal.

foliage; while on beans injury is to foliage, blossoms and pods. In a number of bean fields examined, when the leaves, blossoms and young pods had been injured, less than 50 per cent of the pods on a plant had developed. On many plants, especially near the edges of the field, only one or two pods were left. A typical severely damaged plant showed the foliage badly eaten and only one pod developed, while a typical undamaged plant from the same field had eighteen well developed pods. Often pods are found with large holes eaten in them, rendering the beans unfit for market. In several fields of wax beans, a number of counts were made, which showed that the percentage of injured pods ran as high as 60 on some plants, while the average loss for the fields was 28 per cent.

Remedies for this pest have been rather unsatisfactory. The use of an arsenical spray has been unsuccessful in that it kills only a small percentage of insects. Repellents have also been of little value.

While walking through a field of young cucumbers which was being damaged by Diabroticas, it was noticed that when the beetles were disturbed, many flew up, usually taking a course close to the ground. This suggested the idea that perhaps such a machine as a hopper-dozer would catch many of these low-flying insects. Accordingly it was tried out. A board, 1″ x 12″, fifteen feet long, was fastened on a pair of runners, 2″ x 8″ x 5′. These runners were placed 5 feet apart. As the bean rows were 30 inches apart, the board would cover six rows at a time, two between the runners, and two on each side. To the back edge of the board a framework three feet high was nailed, to which a strip of canvas was tacked. The upper surface of the board, and the front side of the canvas were smeared with a thin layer of tangle-foot. This apparatus was drawn across the field by a horse. The lower board struck just a little below the tops of the plants in the rows. It was tried several times but did not prove the hoped-for success. The beetles, on rising, would fly just ahead of the canvas, or rise up and fly over the top. Even with a hood extending 30 inches forward from the top of the canvas, only 1800 beetles per acre were caught.[1]

Then a galvanized iron pan, 15 feet long by one foot wide by one inch deep, and properly braced along the back and sides, was substituted for the board. The pan was partially filled with an oil heavy enough to avoid slopping over. The pan rested low enough on the runners so that in going along the rows it struck about two inches below the tops of the plants. When the pan struck the plants, many beetles were shaken loose and thrown back into the oil. In fact, a majority of the catch was

[1]Also 250 tarnished plant-bugs (*Lygus pratensis* L.) and 100 lady birds, mostly *Hippodamia convergens* Guer.

composed of those which were thrown back in this manner. Care was taken that none of the apparatus touched the plants ahead of the pan, otherwise many beetles would be disturbed too soon, and escape before the pan reached them. A few leaves and blossoms were also caught in the oil, but the amount was negligible. The above outfit gave a catch of over 2000 per acre, but, as many of the beetles escaped by flying away, a wire screen hood was added, which resulted in raising the catch to 3500 beetles per acre.[1]

The hood was made of a 3-foot wire screen, 15 feet long, which was tacked to the framework at the back of the pan, with the edge of the screen extending down inside the pan, and curved upward and forward to about a foot and a half above the pan (Figure 8). The advantage of the screen hood over the canvas is the same as that of a screen fly-spatter over a solid one, i.e., it permits the passage through of air when in motion.

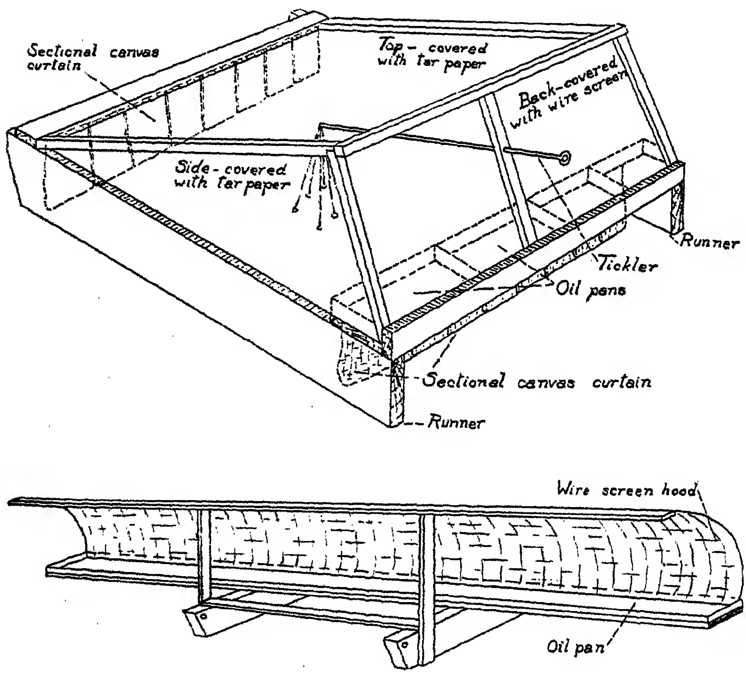


Fig. 8

Fig. 8. Mechanical Devices for Capturing Cucumber Beetles: Lower, adapted for crops grown in rows; Upper, for crops grown in hills. (Original)

[1]Also 350 tarnished plant bugs.

With the above apparatus a man and one horse easily covered thirty acres per day, at a very low cost per acre. As one farmer expressed it, each beetle if left in the field, will destroy at least one blossom or pod, besides doing some damage to the foliage, and by catching 3500 beetles, there will be at least 3500 more pods to the acre, which is approximately 35 pounds.

Of course, such a machine failed to catch many of the beetles the first time, but the low cost of the operation permitted going over the field once or twice a week for several weeks which greatly reduced the amount of damage to the crop. It is known that when food is plentiful, the beetles do not travel far, but remain near their favorite food plant.[1] So with plenty of food, as is usually the case, a reinfestation of the cleaned field would be unlikely.

The best time to catch the beetles was found to be about 10 a.m. and 3 p.m., and a quiet, cool day was better than a hot, windy one. The present cost of the apparatus described above is $3.50 for the galvanized iron trough, $2.25 for the wire screen, and $1.25 for the lumber, making a total cost of $7.00 for material. The catcher can be easily and quickly made.

Such a machine would be serviceable for capturing the beetles infesting any low-growing crop, such as beans, beets, cucumbers, etc., grown in rows, and also such crops as alfalfa up to the time it is about half grown.

The western striped cucumber beetle (*Diabrotica trivatatta* Mann.) also causes extensive damage. This species, however, confines its feeding largely to cucumber, squash and related plants, often causing almost complete defoliation. It also feeds on the stems of young plants which many times results in killing the plants outright. Later blossoms and fruit may be badly damaged.

In 1917 and 1918 the pumpkins and squashes grown by one of the canning companies were severely damaged by cucumber beetles. Both *trivitatta* and *soror* were present, though the former predominated. Since the plants were in hills the machine described above was not entirely suitable, but a similar machine on the same general plan was developed which proved entirely satisfactory. The principle of this Diabrotica catcher was as follows: Cover the entire plant with an opaque box, with light showing only from one side. Cover this side with a tilted wire screen, under which is an oil trough. Place the catcher over the plants and the beetles being aroused, fly toward the light, hit the screen and fall

[1]Journal Econ. Ent. Vol. 8, No. 6, pp. 517-18, by R. A. Sell.

into the oil. The catcher is illustrated in Figure 8. The runners, which straddled the hills, were made of 2 by 12 inch rough pine. They were 6 feet apart and about 8 feet long. The size of the machine should be made large enough to cover the growth of the plants, until all danger of attack is past. The top and sides were light wooden frames, entirely covered with roofing paper. The back frame was covered with screen wire. Directly under this was an oil trough made by cutting 5-gallon oil cans in half longitudinally and fitting them closely together end to end. This made a cheap trough and the cross divisions prevented splashing. Canvas curtains were hung between the runners, both in front and at the back, to shut out entirely all the light, except that which came through the screen. These curtains were made of strips of canvas about a foot wide, which overlapped, so that they would easily pass over the plants, and close as quickly as possible afterward, keeping out the light. Before these curtains were used many beetles escaped under the ends of the machine. The "tickler" was a rod extending through the back screen with light weights on strings at the inside end. The rod fitted loosely in a hole through a cleat across the middle of the screen, so that it could be moved freely from side to side, up and down, and also in and out, and the beetles in all parts of the plants could be disturbed.

In practice the catcher was drawn by two horses and operated by one man. The machine was stopped over each hill and the beetles stirred up. When first disturbed, a large proportion of the beetles dropped to the ground, then immediately crawled up on some projection and flew toward the light where they hit the screen and fell into the oil trough[1]. The longer the machine stayed over a hill, the larger the catch, but it was determined that all things considered, a pause of about 30 seconds was best. With a stop of this length, 75 to 80 per cent of the beetles were captured, and the work could be conducted at an average rate of 100 hills per hour.

This machine was used for two successive seasons and proved very satisfactory. In 1918 a small machine about 2½ feet square was made. This was set by hand over small summer squash plants. It worked well and proved entirely satisfactory while the plants were small enough to be covered by it.

[1]These movements of the beetles were definitely demonstrated as one of the authors spent almost an entire day inside the machine, observing their actions under various conditions.

# EXPERIMENTS WITH A DUSTING MACHINE TO CONTROL THE BEET LEAFHOPPER (*EUTETTIX TENELLA* BAKER) WITH NICOTINE DUST

By HENRY H. P. SEVERIN, Ph. D., *California Agricultural Experiment Station.*
WILLIAM J. HARTUNG, B. S., *Spreckels Sugar Company, Agricultural*
EDWARD A. SCHWING, B. S., *Experiment Station.*
WILLIAM W. THOMAS, M. S.

The first experiments involving the use of dust preparations were carried out on a small scale by Mr. W. W. Thomas to control the beet leafhopper (*Eutettix tenella* Baker). The work was conducted near King City in the Salinas Valley during the 1919 outbreak of the pest. Dusting operations were started in the early part of July and continued until the return flight of the overwintering adults to the foothills had occurred during October.

Daily applications of dust mixtures were used at first to determine the relative value of the insecticides. The plots of beets comprised 1/100 of an acre or 12 rows, 20 feet long. Five rows of beets in each plot were dusted as soon as the seeds germinated and seven rows received no treatment. In later experiments the dust preparations showing a possibility of results were applied daily, biweekly and weekly on larger plots of beets. These plots consisted of 1/10 of an acre or 25 rows 100 feet long. Twelve rows in each plot were dusted and 13 rows were used as a check. The dust was applied with a hand duster. The percentage of curly leaf existing with the use of different dust mixtures at the end of six weeks is indicated in table I.

TABLE I

| Dust mixtures | Applications | Dust per acre lbs. | Curly leaf dusted plots % | Curly leaf check % | Cost of one dusting per acre |
|---|---|---|---|---|---|
| "Black Leaf 40," 10% Kaolin and Lime | daily | 40 | .4 | 62.8 | $6.83 |
| | biweekly | 40 | 10.3 | 57.1 | |
| | weekly | 40 | 24.4 | 53.8 | |
| Arsenate of Lead, 10% Kaolin | daily | 40 | 2.8 | 58.7 | $2.00 |
| | biweekly | 40 | 30.0 | 84.9 | |
| | weekly | 40 | 55.3 | 92.5 | |
| "Black Leaf 40", 5% Kaolin and Lime Arsenate of Lead, 5% | daily | 40 | 1.7 | 31.0 | $4.42 |
| | biweekly | 40 | 9.7 | 54.2 | |
| | weekly | 40 | 20.9 | 54.5 | |

With the harvesting of beets in the vicinity of the experimental fields an enormous congregation of adults was caused in the plots and hence no definite conclusions can be drawn as to the value of the dust as a method of control. When the summer broods make their appearance, flights on the part of the males associated with mating have been observed in other

valleys and in all probability, when beet fields are not isolated invasions from field to field occur. On the other hand, most of the adults which fly into the beet fields during the spring are females which have mated on the plains and foothills and in all probability, the females at the egg-laying stage make only short flights from beet to beet for the purpose of disseminating the eggs. The percentage of curly leaf increases rapidly with the appearance of the summer generations which is not the case when the spring brood invades the beet fields unless the pest is unusually abundant. It is evident that no conclusions should be drawn as to the value of the dust preparations against the summer broods, and dust mixtures should be tested when the spring brood first makes its appearance in the beet fields.

During 1920, a Niagara dusting machine was remodeled and various types of dusting nozzles enclosed in a sheet-iron fumigation box were tested. One type of nozzle terminating in two flattened tubes (Pl.5 fig. 2) blow the dust toward the lower surface of the leaves of two rows of beets. The nozzle which terminates in the funnel-shaped enlargement (Pl.5 fig. 2) is provided with a sieve-plate and forces the dust between the petioles of the leaves.

During the 1920 outbreak of the beet leafhopper, an attempt was made to control the pest with the use of a dust mixture in a beet field near King City, in the Salinas Valley. The experiment was conducted on the Oxnard tract of Ranch 3, which contained about 900 acres of beets. Two lots containing 7.6 acres of beets planted in February were selected, isolated on one side by foothills and surrounded on all other sides by beets. One of the lots of 7.6 acres was divided into four plots and dusted with "5% Nicodust" and the other 7.6 acres was divided into two plots and dusted with "10% Nicodust." "Nicodust 5% and 10%" however, contain only 2% and 4% nicotine, since "Black Leaf 40" contains 40% nicotine sulphate by weight. The dust was applied from 6–10 a.m. before the heavy winds started to blow. The number of applications and the amounts of dust per acre follows:

May 13, plots 1, 2, 3, 4 dusted with about 50 lbs. "Nicodust 5%"
May 20, plots 2, 3, 4 dusted with about 75 lbs. "Nicodust 5%"
May 27, plots 3, 4 dusted with about 75 lbs. "Nicodust 5%"
June 3, plot 4 dusted with about 100 lbs. "Nicodust 5%."
Number of applications 1 2 3 4

May 14, plots 1, 2 dusted with about 75 lbs. "Nicodust 10%."
May 28, plot 2 dusted with about 75 lbs. "Nicodust 10%."
Number of applications 1 2

The pale green adults of the spring brood invaded the beet fields at King City about April 22 or 23. When the foliage was disturbed with the hand during the early quiet morning, the adults were sluggish on account of the low temperature and usually hopped or made short flights and by this method it was determined that there was approximately one adult to ten beets in the experimental plots on May 2.

After the first application of "5% and 10% Nicodust" at the rate of about 50 and 75 pounds per acre respectively, there was no apparent reduction in the number of leafhoppers. In later treatments there was no noticeable decrease in the number of hoppers with "5% Nicodust" at the rate of about 75 and 100 pounds to the acre nor with "10% Nicodust" at the rate of about 75 pounds per acre.

The percentage of curly leaf before the first application of the dust in each lot of 7.6 acres and two checks was determined by an examination of 2000 beets as follows: May 12, 15% in plots before treating with "5% Nicodust," check 19%; 22% in plots before treating with "10% Nicodust," check 12%. The percentage of curly leaf after the application of the dust was determined from 100 beets in each plot and 200 beets in the two checks as follows:

Treated with "Nicodust 5%,"

| | | | |
|---|---|---|---|
| Plot 1, | May 21, 26%, | May 28, 34%, | June 14, 66%. |
| Plot 2, | May 21, 26%, | May 28, 30%, | June 14, 56%. |
| Plot 3, | May 21, 18%, | May 28, 21%, | June 14, 52%. |
| Plot 4, | May 21, 19%, | May 28, 18%, | June 14, 47%. |
| Average | 22.2% | 25.7% | 55.2% |
| Check | May 21, 29%, | May 28, 34.5% | June 14, 63%. |

Treated with "Nicodust 10%."

| | | | |
|---|---|---|---|
| Plot 1, | May 21, 24%, | May 28, 26%, | June 14, 43%. |
| Plot 2, | May 21, 24%, | May 28, 29%, | June 14, 57%. |
| Average | 24% | 27.5% | 50%. |
| Check | May 21, 20%, | May 28, 27.5%, | June 14, 50.5% |

The cost per acre of one application of "Nicodust 5% and 10%" and labor including two men, team and gasoline was as follows:

| | |
|---|---|
| Cost of 100 lbs. "Nicodust 5%" @ 13c per lb. | $13.00 |
| Cost of applying dust | 1.25 |
| Total | $14.25 |
| Cost of 100 lbs. "Nicodust 10%" @ 19c per lb. | $19.00 |
| Cost of applying dust | 1.25 |
| Total | $20.25 |

It was afterwards found that "Nicodust" manufactured by the Walnut Growers Spray Manufacturing Company was not uniform in strength. Beet leafhoppers were confined in screen wire cages (Pl. 8, fig. 1) and the dusting machine passed over these cages in a beet field. Five sacs of "5% Nicodust" applied at the rate of about 125 pounds per acre showed a variation in the killing of the adults from 8-72%.

With the use of "10% Nicodust" one of the men working on the dusting machine was overcome with nicotine. The army gas mask was then employed and no further trouble was experienced by the operator.

During 1921, Hartung and Schwing conducted a series of experiments in order to make a dust mixture which is uniform in strength and efficient in killing the beet leafhopper. The same ingredients were employed in the dust preparation as were used last year.

Preliminary tests with reference to the effectiveness of the dust mixtures in killing the beet leafhopper were conducted in Little Panoche Pass. The vegetation was dry for the most part on the foothills but nymphs and adults had congregated on green Filaree growing in the gullies. An area about 20x10 feet was swept with an insect-net at the rate of 100 sweeps and an average of 34 hoppers was estimated: then the plot was dusted and the number of bugs captured in 100 sweeps was again ascertained. One hundred hoppers were also confined in screen wire cages (Pl. 8, fig. 2) and after dusting the percentage of kill was determined. A dust containing 8% "Black Leaf 40" was applied with an American Beauty hand duster. The percentage of leafhoppers that were killed in four cages varied from 87-97%. It was found that a few adults recovered but most of these died at the end of 20-45 hours when further observations were discontinued. Nymphs and adults were rarely captured in an insect-net by sweeping the dusted area.

Preliminary experiments conducted with a dusting machine in a beet field at King City showed that dust mixtures about six weeks old kept in closed tin receptacles and containing from 6-10% of "Black Leaf 40" were not as effective as the newly made material. The percentage of

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EXPLANATION OF PLATE 5.

(1) Dusting machine in operation. The nozzles are enclosed in a sheet-iron fumigation box. Insert shows screen wire cage which was rolled below dusting machine in operation to determine the percentage of beet leafhoppers killed with nicotine dust. The hoppers were put into the cage through the hole in the cover plugged with cotton.

(2) Front sheet-iron turned over showing nozzles. The nozzle ending in two forked flattened tubes dusts the lower surface of the leaves of two rows of beets. The nozzle ending in a funnel is provided with a sieve-plate which forces the dust between the petioles.

beet leafhoppers which were killed in screen wire cages with old dust preparations varied as follows:

Kaolin, Lime, "Black Leaf 40" 6%, killed 16%.
Kaolin, Lime, "Black Leaf 40" 8%, killed 75%.
Kaolin, Lime, "Black Leaf 40" 10%, killed 16%.

The dust mixture containing 10% "Black Leaf 40" was now applied to one acre of beets isolated by alfalfa fields and the percentage of beet leafhoppers that were killed was approximately determined. Another acre of beets was used as a check or control at a distance of about 1000 feet from the dusted field. The nearest beet fields were about a mile away from the two experimental areas. Before dusting, three men estimated the number of bugs present in different rows of beets in the two acres during the early morning. It was found that there was an average of 6 adults to 100 feet of a row of beets. After applying the dust at the rate of about 100 pounds to the acre, there was an average of 5 adults to 100 feet of a row of beets. The inefficiency of the dust was due to the fact that the lime was partly air-slaked and lost some of its active properties. Four days later another dust mixture containing freshly burnt lime was applied to the same acre of beets. Three days after dusting there were 4 adults and 1 nymph in 630 feet of beets or a reduction of 84% of the hoppers. In the acre used as a check, there were 6 adults and 9 nymphs to 100 feet of a row of beets.

The percentage of leafhoppers which were killed in screen wire cages with the newly made dust containing 10% "Black Leaf 40" and applied with a dusting machine at the rate of about 100 pounds to the acre varied as follows:

| | Dead 7 hours. | Dead 24 hours. | Dead 48 hours. |
|---|---|---|---|
| | 59% | 84% | 96% |
| | 92% | 95% | 100% |
| | 56% | 72% | 82% |
| Average | 69% | 83.3% | 92.6% |

No conclusions can be drawn as to the value of dust mixtures as a method of control for the beet leafhopper, due to the fact that the beets were planted after the invasion into the cultivated area had occurred. The spring brood flew into the beet fields near King City between April 25-30, 1921. The beet seed was planted on May 9 and germinated on May 26 in the dusted and check acres. The first application of dust was applied on June 20, and the second on June 24, after the hatching of the second brood nymphs had occurred. It is evident, however, that with a reduction of 84% of the hoppers in a dusted acre of beets, a marked decrease in the percentage of curly leaf would occur in isolated beet fields providing the dust is applied shortly after the spring flight of the adults into the cultivated area.

ACKNOWLEDGMENT

The writers wish to express their sincere thanks and appreciation to Mr. W. S. Suttie, who applied the dust with the dusting machine, and who showed a remarkable interest in the Eutettix problem and faithfulness in his work during the past three years.

## DISTRIBUTIONAL AND ECOLOGICAL NOTES ON ANOPHELINE MOSQUITOES IN CALIFORNIA[1]

By WILLIAM B. HERMS,
*Professor of Parasitology, University of California*

No doubt it will be readily conceded that a complete study of the detailed distribution of Californian anopheline mosquitoes or any other species is a matter of considerable proportions presenting many obstacles such as extensive area, extreme elevations, transportation difficulties, etc. In area alone California's 153,650 sq. mi. of territory represents the combined areas of Mississippi, Louisiana and Alabama, a mosquito survey of any one of which would represent a magnificent task. However, an attempt has been made to carry out a state wide mosquito survey in which a distance of 18,000 miles was covered by automobile alone, reaching every county in the state. Elevations were reached ranging from about 200 feet below sea level in the Imperial Valley to about 10,000 feet above sea level in Tuolumne County. A total of 690 mosquito collections were made consisting of 6650 mosquitoes of all kinds. It was found that there are three species of Anophelines in California, viz., — *A. occidentalis* D. & K. (the western form of *A. quadrimaculatus* Say), *A. punctipennis* Say and *A. pseudopunctipennis* Theobald. Although the survey was intended to be a malaria-mosquito survey, it was considered highly important to include all available species of mosquitoes in every collection in order to know the relative abundance of anophelines in any one locality.

For purposes of comparison and administration the state was divided into the following divisions; viz., Sacramento Valley Counties, San Joaquin Valley Counties, Sierra Counties (northern and middle), Plateau Counties (northern and middle), Coastal Counties (northern, middle and southern), and Southern California as given in detail in earlier papers.[2,3] Furthermore in developing the totals it was found

[1]Contribution from the Division of Entomology and Parasitology, College of Agriculture, University of California.

[2]Occurrence of malaria and Anopheline mosquitoes in Northern California. U. S. Public Health reports. Vol. 34, No. 29, pp. 1579-1587. July 18, 1919.

[3]Occurrence of malaria and Anopheline mosquitoes in Middle and Southern California. U. S. Public Health Reports. Vol. 35, No. 6, pp. 275-281, Feb. 6, 1920.

convenient to consolidate all the counties north of Tehachapi into two divisions, namely Northern California and Middle California, designating everything south of Tehachapi as Southern California.

Although this paper is not concerned with the occurrence and distribution of malaria in California it is nevertheless interesting and apropo as well to review the conclusions reached in the malaria-mosquito survey recently completed (See U. S. Public Health Reports Vol. 34, No. 29) viz:—

Comparing the average annual death rate per 100,000 of Northern California and Middle California it will be seen that the rate is almost the same, namely 4.9 for the former and 4.7 for the latter. Furthermore, the percentage of Anophelines taken in both divisions is not widely divergent, i.e., 38 per cent in the former and 31.1 per cent in the latter and of these *A. occidentalis* and *A. punctipennis* combined represented 77.9 per cent of the total Anophelines in the northern division and 56.9 per cent in the middle division, the remaining being *A. pseudopunctipennis*, believed to be negligible in its relation to malaria. This stands in rather striking contrast to the conditions in Southern California, where the average annual malaria death rate is only .9 per 100,000 population, and where 49.6 per cent of the mosquitoes collected were anopheline, of which however 69.3 per cent were *A. pseudopunctipennis*. It will, furthermore, be seen that the average number of mosquitoes per collection for these two divisions (northern and middle) was 9.9 for Northern California and 13.1 for Middle California, indicating a greater abundance of mosquitoes for the latter, but it is interesting to note that the relative number of *A. occidentalis* and *A. punctipennis* combined per collection was very similar, namely 3.6 for the northern area and 4.1 for the middle area, corresponding more or less closely in proportion to the malaria death rate, and that the average number of mosquitoes per collection for Southern California was 10.1, while the average number per collection of *A. occidentailis* and *A. punctipennis* combined was only 1.7 and the malaria death rate .9 per 100,000.

Although the San Joaquin Valley is commonly regarded as not greatly unlike the Sacramento Valley topographically, it will be seen that the annual malaria death rate for the latter is almost twice as high as the former, namely 6.3 per 100,000 for the San Joaquin and 10.9 for the Sacramento. It would appear that this high rate for the latter is explained by the high rate of effective Anopheline carriers, i.e. 46.6 per cent of all mosquitoes taken in the Sacramento Valley were *A. occidentalis* and *A. punctipennis* combined, and only 18.8 per cent consisted of these two species in the San Joaquin Valley.

While the two groups of Sierra counties, northern and middle, show an approximately equal malaria death rate, namely 9.1 for the former and 10.5 for the latter, there is much divergence in the anopheline mosquito population, as far as collections were made. Owing to a time limit in carrying on the survey during 1919, the middle Sierra counties were not as well covered as had been contemplated, and in the second place Mariposa County, herein included, represents a strong transition, both in faunal and topographic conditions, factors which are not easily overcome in a classification based on county lines. In spite of this there is, nevertheless a high percentage of *Anopheles punctipennis*.

The coastal counties, northern, middle and southern, show a much more consistent rate, both for malaria and for Anophelines, i.e. a very low malaria rate and a very high rate of *A. pseudopunctipennis*, the predominant Anopheline.

That the relation between potentially effective anopheline carriers alone and the malaria rate should not be pressed too hard is indicated by the fact that the combined *A. occidentalis* and *A. punctipennis* rate for the San Joaquin Valley stands at 18.8 per cent, with a malaria death rate of 6.3 per 100,000 population, as compared with Southern California with a rate of 15.2 per cent (*A. occidentalis* and *A. punctipennis* and a malaria death rate of only .9 per 100,000. In other words, if the potentially effective Anopheline rate alone were a sufficient indicator of malaria incidence, Southern California should have a much higher rate than it actually has. This seeming discrepancy is readily explained by the fact that the two areas in question are in reality not comparable, owing to divergent fundamental physical factors which control biological phenomena. For example, one often travels many miles and tries many times in the more arid part of Southern California before mosquitoes of any kind are encountered, and then they may be present in considerable numbers, i.e. they occur in isolated and widely separated spots. Thus, for example, after many miles of travel and careful search without success rather suddenly our party encountered enormous numbers of *Anopheles occidentalis* at a hot springs resort in Riverside County, in a district removed from centers of population. Again, many of the Anophelines (*A. occidentalis*) in this part of the state were taken in Ventura County, particularly near the city of Ventura, where the summer temperature is uniformly quite low, vitally influencing biological interrelationships. The occurrence of malaria is dependent upon a combination of factors in addition to the presence of potentially effective mosquito carriers, among them being temperature (both above and below a certain range), proximity of population to anopheline foci, a sufficient production of Anophelines, etc.

*Anopheles occidentalis* D. & K. in California occurs most commonly in the Sacramento and San Joaquin Valleys, practically throughout the former, and from within a very few miles of both the Oregon and Mexican boundaries, i. e. straight through the state North and South from Siskiyou to San Diego Counties. Except for the Sacramento Valley where infection is general and almost so for the San Joaquin this species was found to occur only in more or less isolated foci in other parts of its range. It was taken in great numbers within a few feet of the ocean in Ventura County where cool fogs generally prevail, and the temperature is consequently uniform, to an elevation of 5,480 feet in Sierra County where the summers are hot and the winters are cold. In general, however, the Sierra except the foothills are free from *Anopheles occidentalis.* The locality in Sierra County undoubtedly is the result of influences from the Northeast as are also the localities in Modoc and Lassen Counties. Ordinarily this species is abundant throughout its range.

*Anopheles punctipennis* Say on the other hand shows a distinct inclination to hug the Sierra foothills with sporadic foci in but very few other parts of the state. Only one collection of mosquitoes south of Tehachapi contained this species, namely a few specimens in one locality in San Diego County. Unlike either *A. occidentalis* or *A. pseudopunctipennis* this species is not noticeably abundant in numbers of individuals in any one locality.

*Anopheles pseudopunctipennis* Theobald has a very wide distribution in California, almost coinciding with *A. occidentalis,* though absent from the extreme northern tier of counties. This species is also very abundant everywhere that it occurs.

In addition to the collection of adults, larvae were taken and notes made relative to breeding habits. Field laboratories in connection with mosquito abatement districts and other special laboratories as well have been maintained in various parts of the state. Much data has thus been accumulated, of which little has as yet been correlated. That *A. occidentalis* breeds by preference in rather clear pools of water in which vegetation is fairly abundant and open to sunshine seems to be the case. *A. punctipennis* on the other hand apparently prefers quiet shady pools. *A. pseudopunctipennis* evidently breeds by preference in clear shallow pools along the edges of receding streams. All three species are partial to mats of spirogyra which provide a convenient shelter against natural enemies such as predaceous aquatic insects and surface feeding fishes.

During the summer of 1920, from May 12 to July 13, daily collections of mosquitoes were made at Vina (Northern Sacramento Valley), one

series being indoors and the other outdoors. The indoor collections were made regularly in the same buildings consisting of a cowshed, a washhouse, showerbath, storehouse and dwelling, while the outdoor collections were made under a short wooden bridge within ten to twelve feet of an aggregation of shacks occupied by chinese and negroes. The indoor series taken in an area where control measures were in progress does not represent a large number of mosquitoes but the fact remains that of seventy-seven anophelines taken, fifty were *Anopheles occidentalis* (including only one male) and twenty-seven were *A. punctipennis* (including two males) or practically twice as many of the former. On the other hand the outdoor series represented a total of 343 anophelines of which 102 were *A. occidentalis* (42 males and 60 females) and 241 were *A. punctipennis* (130 males and 111 females) or something over twice as many as the latter.

These collections bear out very well the general observations that *A. occidentalis* like *A. quadrimaculatus* is typically an invader of houses and consequently of greater importance as a malaria carrier, while *A. punctipennis* is chiefly an outdoor biter, porch biter, etc., and of less importance as a malaria carrier. During the entire period of two months the well screened cottage which was occupied by our party was not invaded a single time by *A. punctipennis* while *A. occidentalis* was a common visitor. Our experience with *A. pseudopunctipennis* during this period was so limited that no general deductions can be made, however, in our wide experience with this species in other parts of the state we are inclined to believe that it is a typical field species although it bites human beings very freely.

As may be seen from the above the number of males and females for the two species under consideration is not far from equal. In this connection it is interesting to note that the males disappear about the middle of November and reappear the following year during the last week in April. *A. occidentalis* winter over in the adult stage, the females often appearing in enormous numbers during the warmer days of February and March when egg laying begins. These observations are important from the standpoint of control and it has been consistently advised that mosquito control operations should begin in the autumn with a strong intensive campaign to clean out the last brood and again another early spring campaign to eliminate the first brood. Remarkable results have thus been accomplished.

# THE SEASONAL HISTORY OF *ANOPHELES OCCIDENTALIS* D. & K. IN CALIFORNIA[1]

By Stanley B. Freeborn, *University of California*

The control of malarial mosquitoes has been operated for years on the assumption that Réaumur's classical work on the life history of *Culex pipiens* was a suitable basis for the life history of all mosquitoes. It is only within a comparatively few years that ecological studies have been conducted with anopheline mosquitoes to lay the foundation for a more economical and efficient method of control operation than that which followed the old slogan of "Oil or drain all standing water" with no reference to type of breeding place, presence of larvae, or time of year. There is no question in the writer's mind regarding the *success* of a campaign carried out along these lines, but in the light of what we know regarding selective breeding and the limited generations of the insects, the waste in materials, time, and energy of these "shotgun" methods is appalling.

Perhaps the most important field for improvement can be based on the study of the life history. It was the writer's good fortune to be detailed to co-operate in June 1919 with a party of U. S. Public Health Service officers at Chico, California where investigations were being carried on regarding the status of anopheline mosquitoes in the rice fields. In this month he began a weekly collection of all mosquitoes appearing under a highway bridge situated some distance from the nearest rice field. This procedure was maintained by the writer until other work called him away in August after which Mr. W. C. Purdy, special expert of the U. S. P. H. S., made the weekly collections forwarding them to the writer for identification. The bridge under which the collections were made was a modern, concrete, highway structure spanning a natural drainage slough, continually holding water but without a noticeable current in the immediate vicinity of the bridge during most of the year. Mosquito breeding, during the season, was prolific in many parts of the slough. No control measures were undertaken within five miles of the bridge. Collections were made in shell vials containing chloroform or cyanide, the specimens transferred to pill boxes and transported to the laboratory for identification. All mosquitoes resting on the roof or sides of the bridge were taken except on certain occasions when the single collection would have run into the thousands. At such times the distribution of the mosquitoes under the bridge was observed and enough sections

[1]Contribution from the Division of Entomology and Parasitology, Univ. of California, College of Agriculture.

covered to approximate a half or a quarter, from the identification of which the whole population was estimated. In all, 26,010 mosquitoes were collected and identified in the sixteen months of the project, of which 5,756 were *A. occidentalis* D. & K. Because this species found its optimum breeding conditions in the immediate vicinity of the collection point and its more important bearing upon the malaria question, for as

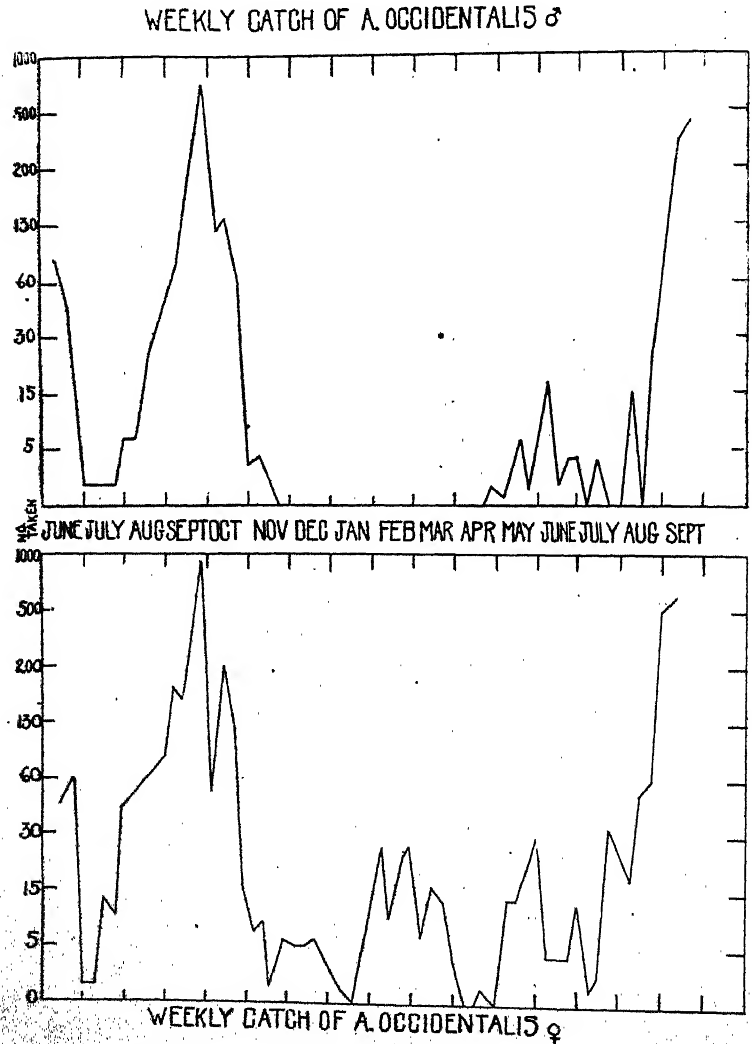


Fig. 9. Seaonal Occurence of *A. occidentalis*

the western counterpart of the eastern *quadrimaculatus* Say it is undoubtedly the most important malaria carrier in the West, the above explanation and charts are offered.

The study of the chart of male collection establishes two points (1) that hibernation, indicated by the absence of males starts just after the middle of November and (2) the curves are strongly suggestive of only two generations a year with a possibility of the earliest members of a third overtaking the stragglers of a second during September with the appearance of a possible fourth in October or November. In connection with the first point, "hibernation" is used in a rather loose fashion as no true dormancy occurs in the overwintering females. They frequently change their places of refuge as shown by the fact that we were able to make repeated complete collections beneath the bridge thruout the winter. However, they show no inclination to feed in the open thruout the period, the earliest records of this being in January in unusually warm weather.

In February of each year the females begin to emerge from their overwintering refuges. In the year shown on the chart (1920) this emergence was accomplished gradually, but on the following year the emergence was extremely uniform and striking. About February twentieth communities in many parts of California were deluged with enormous swarms of *A. occidentalis* females which invaded houses, biting viciously even in bright sunlight. By the last of the month, however, they had practically disappeared. During this flight of emergence, the area infested is almost always greater than at any other period of the year, many districts being invaded in February by *A. occidentalis* that are entirely free from them during the remainder of the year. The only explanation at hand is that the unusual length of flight at this time is a biological stimulus to ensure the spread of the species. Females dissected during the winter and at the start of the emergence flight contained round, half grown eggs in the ovaries but those taken later showed fully developed eggs. Some unfed migrants given a blood meal in the laboratory developed mature eggs in approximately 48 hours. This migratory flight from hibernation quarters on the part of the overwintering females is the official opening of the season for *A. occidentalis* Eggs are deposited and the adult population falls off very rapidly in numbers with adult mosquitoes practically absent in April. From the information at hand, which is limited to a single experiment and the study of the chart of female *occidentalis* collections, it would appear that the overwintering females lay but a single batch of eggs before death overtakes them. Several migrant females were confined in the laboratory in the spring of 1920, and given blood meals whenever they could be

induced to bite. All deposited single batches of eggs and then died despite the utmost care without ovipositing a second time in contrast to the midseason females which frequently deposit two and sometimes three batches of eggs in captivity under similar circumstances. The study of the collection chart of both males and females shows the emergence of the first generation of the year reaching its peak during the first of June and is followed by a rapid decrease in numbers that would have been replaced by a more sustained curve had there been more than one series of deposited eggs. It is interesting to note the three peaks that denote the emergence of first brood males in April, May and early June and hazard at their connection with the three peaks of overwintering females that were abroad in February and March (the emergence from hibernation being unusually gradual during the year in question.)

The individuals of this first generation which began to emerge from pupation in May and June are relatively few in number. This may be due to the small number of eggs deposited by the overwintering females as advanced above, or it may be due to the hazards of life at this time of year. The average low temperature prolongs the larval life of this generation to approximately two months during which time they are constantly exposed to their predaceous and parasitic enemies and to the danger of being washed out by high water, a factor which disposes of many mosquito larvae breeding along the edges of streams fed by melting mountain snows.

Fertilization of the females takes place immediately upon emergence. The males emerge first and may be seen hovering over or near the breeding places in small swarms awaiting the appearance of the females. The universal fertility of captured wild specimens points to a very perfect biological arrangement enabling an infallible fertilization of the female and strengthens Knab's conclusion based on his observation of anopheline mating that the female seeks out a male from the hovering swarm.

The egg deposition of this first generation begins within a few days of its emergence. The average number of eggs deposited in a single laying by *A. occidentalis* is according to Herms and Freeborn, approximately 200 eggs, a much greater number than had previously been supposed. The number of layings can not be estimated with our present technique. The two biological factors that have hindered us in this work are (1) inability to produce copulation with bred specimens in captivity which forced the use of wild material regarding whose previous egg deposition we had no check and (2) inability to keep laying females alive in captivity until their ovaries no longer showed the reappearance of a new batch of eggs following the deposition of the second and on one occasion a third laying. Every attempt was made to reproduce natural conditions in

respect to temperature, humidity, breeding places, and food but death always resulted with one exception before the third deposition and subsequent dissection invariably showed the ovaries filled with eggs which from a biological standpoint would indicate a premature death. The total number of eggs that can be deposited by a single female of this first generation under natural conditions must remain a conjecture at this time. Under laboratory conditions the greatest number of separate layings for *A. occidentalis* was three, with a total deposition of four hundred and ninety-one eggs.

With this propensity for egg laying in mind which under natural conditions is continued thru an unknown number of batches, the ascending curve beginning in late July and reaching its peak in late September is easily foreseen.

The origin of the overwintering females is a difficult point to fix. However, Mitzmain has shown that engorged females are unable to pass the winter successfully. It is to be inferred therefore, that they are the members of the last batch of the season which occurs if we refer to the chart of male collections and estimate the life of the male *occidentalis* at a week, about the fifteenth of November. Whether these individuals are technically stragglers of the second generation represented by the September peak or of a third or fourth generation is at present unknown.

The practical points from a control standpoint in these studies resolve themselves about the time for offensive measures against malarial mosquitoes. After the migratory flight of the overwintering females there follows a rapid decrease in the adult population to the point when practically every living member of the species is in the aquatic larval stage, (early April in the locality represented in the charts.) The drainage, filling or oiling of all breeding places at this period, if carefully done controls, with the exception of the subsequent breeding of foreign invading females, the entire generation that are the progenitors of the summer and fall broods. If this opportunity is neglected, the emerging females capable of depositing many consecutive batches of eggs lay the foundation for an overlapping series of adults and larvae that ensure the survival of the species over a continued campaign directed against the larvae.

Once again during the year man is given his chance to strike a decisive blow against this species. This opportunity comes in California in October or in any locality where hibernation occurs soon after the fall peak of the adult population takes place. At this time, the number of adults are being rapidly depleted but breeding waters are stocked with larvae which will give rise to thousands of females emerging too late to

feed and consequently fitted to overwinter and produce the eggs for the first generation of the next year. Control work pursued as the adults of the fall peak are decreasing and directed against the larvae invariably reduces to the minimum the numbers of overwintering females.

The practicability of these measures is not limited to a theoretical examination of the charts but has been demonstrated in actual field practice in California. In the fall of 1919, the writer had charge of an anti-malarial campaign at Anderson in Northern California, where preliminary work was undertaken in August. By October first, as far as repeated field inspections could determine, control was absolute. The work was continued on permanent ditches until December first during which time no larvae were observed. Work was then discontinued by our project, the responsibilities being assumed by local authorities. On the following spring at the time of the migratory emergence flight in surrounding areas, Anderson was comparatively free, a few adults drifting in from unprotected areas with the result that the individuals of the first brood even if uncontrolled would have been of little sanitary importance.

In the spring of 1921, the abrupt and overwhelming migratory emergence flight so incensed an already educated municipal population in the northern part of California that public clamor demanded immediate action on the part of the health authorities who responded by draining and oiling all breeding places in the municipality, hitherto a notorious malaria center. The first brood never emerged, and by midsummer mosquito control operations were discontinued as no larvae could be found within the area. On previous years when work was started at a later date the entire appropriation for mosquito control was invariably exhausted before the season drew to a close and mosquito control was problematical. This year, however, with work starting at a very early date mosquito control was absolute by midsummer and fully one-half the appropriation which was the same as on previous years, remained in the city treasury.

As *A. punctipennis* Say and *A. pseudopuncipennis* Theobald did not breed in the immediate vicinity of the collection point, the discussion is limited to *A. occidentalis* D. & K. Of these two species above mentioned, little is known concerning their hibernation in California. No records of adult capture during the winter months are at hand nor have their larvae been taken during this period[2]. Control measures directed against *A. occidentalis* as outlined above would control these species as well should they be shown to winter over as larvae.

[2]Mitzmain has observed overwintering females of *A. punctipennis* in Mississippi.

An interesting feature in the study of these collection data is to be found in a comparison of the first season (1919) with the second season (1920). During 1919 the nearest rice field was some distance away but during the intervening winter the entire area surrounding the bridge was leveled for rice and the collections for 1920 therefore show the rate to be expected from rice fields in that particular vicinity. The writer does not care to comment on this phase of the problem as Mr. W. C. Purdy of the U. S. Public Health Service, who so kindly made the collections upon which these studies are based, already has in preparation a report of this phase of the work which will undoubtedly be published at an early date by his service.

## Summary


1. Efficient mosquito-malaria control depends on an intimate knowledge of the life history of the mosquito in question and can not be based on the known life history of another species.

2. In California *A. occidentalis* D. & K. overwinters as an adult female, hibernation beginning about November 15th and terminating in February in a widespread migratory flight.

3. These overwintering females evidently lay but few eggs and have all disappeared by April at which time all the individuals of the species exist as larval forms.

4. The first brood of the year reaches its peak in June. The individuals of this brood have the ability to lay many series of eggs which accounts for the accumulative peak of mosquito population that occurs in September.

5. The species apparently passes thru two generations in a season with the possibility of a third or fourth under the most favorable circumstances.

6. Control work directed against the larvae after the spring migratory flight of overwintering adults and again after the peak is reached in the fall, if carefully done, will hold this species under control.


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# *ANURAPHIS HELICHRYSI* KALT., A PEST OF PRUNE, PLUM, AND RED CLOVER IN IDAHO

By RALPH H. SMITH, *Entomologist,*
*Idaho Experiment Station, Moscow, Idaho.*

*Anuraphis helichrysi* Kalt. is the most important plant louse affecting prune and plum in Idaho. Injury has been common in both domestic and commercial orchards during the past four years. Red clover and garden asters, the most important summer host plants, are frequently very heavily infested. Injury to clover during the summer of 1921 caused a marked reduction in the yield of seed in several fields near Twin Falls while florists and housewives have experienced real difficulty in successfully growing garden asters on account of this aphid.

HISTORICAL. The species first came to the attention of the writer in the spring of 1918 when on taking up work in Southern Idaho he found the foliage of prune, plum and peach to be infested with aphids to such extent that the leaves of many trees either mostly fell off or remained strongly curled thruout the summer. The aphid affecting peach was identified as *Myzus persicae* Sulz. The species infesting prune and plum was identified by Dr. C. P. Gillette and later by Dr. A. C. Baker as *Anuraphis helichrysi* Kaltenbach.

The pest doubtless has been present in Idaho for many years. Edmundson[1] does not mention it among the orchard insects of Idaho but we are led to believe that he and probably others have confused it with *Anurpahis cardui* L. (*A. pruni* Koch) which ranks next to *A. helichrysi* as an aphid pest of plum, at least in the southern part of the state. We have been able to find only two collections of aphids from prune and plum that were made in Idaho previous to 1918. One of these is a yet undetermined species collected in 1910; the other, which is labeled merely "*Aphis pruni* on prune, collected 1911", is *Anuraphis helichrysi* Kalt.

SEASONAL BEHAVIOR. Migrant females and males begin developing on the summer host plants during the latter part of August at Twin Falls (alt. 3700 ft.). They are found in fair abundance on foliage of prune and plum by the 15th of September. The migrants and greenish to reddish-brown oviparia feed preferably on the under surface of the leaves and especially within the closely curled leaves that have been curled by the spring generations. Eggs are deposited at the bases of buds and on the bark of branches. Hatching takes place very early while the buds of prune

[1]Insect Pests of the Orchards and Gardens of Idaho and their Control. Idaho Exp. Sta. Bul. 87, 1916.

and most varieties of plum are apparently entirely dormant and those of peach are only slightly swollen. The stem mothers which at firts are dark green but become distinctly reddish with a brown band on the dorsum of each body segment at maturity, feed at the bases of buds and thru the bark of the last season's growth until the fruit buds begin to open. The stem mothers begin reproducing about the time green tips appear on the fruit buds of prune. Migrants occur chiefly in the third and succeeding generations. The progeny of the stem mothers are pale green with the body integument semi-translucent; only the distal ends of the antennae and the tarsi show slightly dusky. In some instances plum trees have remained heavily infested thruout the summer.

CHARACTER OF INJURY. The aphid is strictly leaf-feeding on prune and plum but on red clover and other summer host plants it feeds chiefly on the more concealed parts of stems, petioles and blossoms. Infested leaves of prune and plum curl tightly and develop numerous pocket-like galls. New leaves at the tips of infested branches become curled as soon as they start to develop. The new growth of such branches is somewhat stunted and malformed and there appears to be a tendency toward premature dropping of the fruit as a result of the infestation of the foliage. Infestation is usually confined to one or a few branches on moderately affected trees, the aphids not spreading readily from one part of a tree to another.

HOST PLANTS. All varieties of prune and plum that have come under our observation have been susceptible to attack though seedlings and root sprouts appear to be favored. Occasional colonies have been found on peach and apricot in early spring but these did not thrive in the same vigorous manner as did colonies on Italian and Hungarian prunes, and varieties of plum. The most favored summer host plants in Idaho as determined at present are *Trifolium pratense* L., garden varieties of *Aster* sp., *Chrysanthemum* sp., *Dahlia* sp., and *Erigeron canadensis* L. The aphid has been observed in smaller numbers on *Achillea millifolium* L. *Solidago serotina* Ait., *Trifolium hybridum* L., *T. repens* L., and *Solidago* spp.

CONTROL MEASURES. Black Leaf 40 used at the rate of ¾ pint to 100 gallons of water with soap as a spreader or to 100 gallons of dilute lime-sulfur solution, and applied just before the buds open on prune and plum has given perfect control. Lime-sulfur at winter strength has not been effective in destroying either the eggs or the young stem mothers. Control of the pest in red clover fields is somewhat complicated and is discussed in detail in a bulletin on the Clover Aphis (*Anuraphis bakeri* Cowen) now in course of publication by the Idaho Experiment Station.

# THRIPS INJURY TO PEACHES IN SOUTHERN CALIFORNIA

By GEO. P. WELDON, *Pomologist,*
*Chaffey Junior College of Agriculture, Ontario, Calif.*

In the fall of 1914 some Elberta peaches were received at the office of the State Commissioner of Horticulture, Sacramento, from Placer County. These peaches showed a type of injury which at that time was not recognized as being due to insects. A number of growers in the vicinity of Auburn and New Castle were complaining of damaged peaches which were noticed at the time the fruit was being packed. It was not until the next season that this injury was found to be due to the attack of some species of thrips. County Farm Advisor E. O. Amundson, in examining the blossoms of peaches early in the spring of the year, found that they were full of thrips. He later made observations which showed conclusively that the injury which had been observed commonly the previous season was due to this little insect.

No data is at hand which would enable one to make an estimate of the injury which was done during the years 1914 and 1915 in Placer County, however, it is known that in some sections severe damage resulted from the attack of this insect.

In August of 1919 the writer moved to Southern California taking up work with the Chaffey Junior College of Agriculture. It was found in looking over peaches that were coming into local canneries at Ontario that quite a large percentage of them showed injury similar to that which had been noted in Placer County. Estimates were made of the percentage of fruit which had the distinct marks of thrips and it was decided that at least twenty-five percent of all the fruit which was handled by two large local canneries showed marked infestation. Most of the growers and men associated with the canneries were undecided as to what had caused the injury. A few of the older growers however, recognized the fact that thrips were responsible for this injury as from time to time in past years they had suffered losses from it.

In 1920 the writer had an opportunity to make more extensive observations than previously; these during a year when the pest was worse than it had ever been known in the history of peach growing in Southern California. The loss, while it could not be estimated accurately during this season, would represent a large sum of money. It was estimated by careful observations in the field and of the fruit as it came into the canneries that more than fifty percent showed injury

from thrips. While this injury does not render the peaches valueless, many of them are culls that must be canned as very low grade fruit, while none of them can be packed in the higher grades.

## Life History

While it was not possible to make careful enough life history studies of the pest to enable one to conclude definitely as to where it spends the winter season, etc., it was found that as soon as the peaches began to bloom in the spring adult thrips immediately got into the blossom where egg laying took place and where feeding was done by both adults and larvae.

Throughout the time of blooming of the peaches and later until the time when the husk shed from the little peach the injury continued. Practically no injury was done after the shedding of the husk. The very uneven blooming season during 1920 made it difficult to get any results whatsoever with a contact spray. Various things were tried but with no success as will be indicated later. The blooming period lasted approximately two to three months, according to the variety and all this time as the trees were coming into bloom, thrips were going into the blossoms.

After the peaches had attained considerable size many thrips were found in the tender growth at the tips of the twigs. In fact, throughout the entire summer season some of them could be found in such places but none on the fruit for any length of time after the shedding of the husk. The injury therefore, by this species, was found to be done while the trees were in bloom and afterwards up to the time of the shedding of the husks.

## Demonstrations

A series of demonstrations were planned during the season of 1920 which were designed to give the growers an idea as to how the pest might be controlled. It had been claimed by those who had worked on the pest in Placer County that a thorough spraying while the peaches were in bloom, or a little later, with Nicotine Sulfate Distillate Emulsion mixture which is so successfully used in pear thrips control, would bring results. After one or two demonstrations had been conducted it was determined that so small a percentage of the thrips was being killed that the spraying was not paying for itself. Careful observations of the insect in treated blossoms led to the belief that not over fifty percent were killed by a single application of the Nicotine Sulfate Distillate Emulsion mixture. It must not be understood from this that the mixture did not kill for it was found that where it was

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possible to get the spray on the thrips, that there was no trouble in killing them. The difficulty lay in being able to get the spray into the blossoms and later under the husks of the little peaches.

Various types of nozzle were used and as high pressure as was possible to obtain with a power sprayer was tried in an effort to get the spray where the thrips were protected by the blossoms or the husks. In all the work the fact was apparent that the protection of the stamen bars and the pistil of the peach blossom was such that it was almost impossible to reach the insects with the spray and after the peaches had formed the same difficulty was experienced in getting the spray beneath the dried-up blossom or husk. Thus, after recommendations had been made regarding the way this insect might be controlled, spraying was stopped in orchards of the community because of failure to get the desired results.

## Dusting

Samples of Nicodust manufactured by the California Walnut Growers Exchange were also used in some experiments. Regular strength of this material as well as double strength; also a Nicodust material made from nicotine and sulphur, were all tried but none of them were successful. Blossoms that were thoroughly coated with these dust materials were brought into the laboratory and in twenty-four hours' time it was found that the thrips were apparently just as lively as before the material was applied. A few thrips seemed to be killed where the dust came in actual contact with them but where it did not, there seemed to be no effect from fumes and thrips inside of blossoms where the stamen bars and pistil were heavily coated with this material were as lively as ever.

In 1921 the dusting experiments were repeated although it was not possible during this season to find as bad an infestation as most of the orchards had the previous season. The same negative results were secured in 1921 as in 1920.

## Injury

The characteristic injury done to peaches by thrips assumes a number of different forms which seem to be influenced somewhat by the variety.

In the case of Phillips Cling variety for example, a very common type of injury is a little conical shaped swelling on the surface of the fruit. In the case of the Tuskena variety the injury that is more commonly noticed consists of a pitting or dimpling of the surface of the fruit. In other cases where the fuzz has been removed entirely by the thrips in feeding, the skin will be colored a deep red and will be smooth like the

skin of the nectarine. Wavy red lines are commonly seen on such varieties as Lovell, while russet or scabby patches and streaks may be found on practically all varieties where injury has taken place.

This injury, while as has already been stated, does not seriously impair the quality of the peach, makes it very difficult to remove the peel when the fruit is being canned. In the modern commercial canneries the peaches are peeled by means of lye and it was found that the lye bath did not successfully remove the skin from thrips injured peaches, thus necessitating hand trimming of the portions of the fruit affected, which is slow and expensive.

## Other Hosts

Not only is the species of thrips which is found injuring peaches injurious to this fruit, but it is also very commonly found on plums, apricots and nectarines. In the case of the nectarine the injury is more severe than with any other fruit where the pest has been seen. Plums are frequently badly injured while apricots are injured to a lesser extent. The Royal variety which is more commonly grown in California than any other variety of apricot, does not seem to be so susceptible to attack as the Tilton variety, another commercial sort which is commonly grown. Wherever the latter variety has been observed, large numbers of thrips. have been found feeding upon it.

A species that may be identical with the peach species has been found feeding on apples in the Yucaipa section of San Bernardino County. During the season of 1920 there were large numbers of thrips in the blossoms of the apple but the injury did not seem to be great.

## Seasonal Occurrences

Fortunately the thrips pest seems to vary greatly in its attack from season to season. As has already been stated during the season of 1919 and 1920 the injury in the Ontario-Cucamonga-Pomona section of Southern California, was very severe. This year, 1921, the injury was slight and in the spring it was rather difficult to find orchards where there were enough thrips to make experimental work worth while. Then too, the blooming season of peaches in 1921 extended over a much shorter period than the previous season. This factor in itself bears a very close relation to the damage done by the insect for when there is a long blooming period there is a correspondingly long time for the insects tofeed in the blossom and under the husks which of course, means far greater injury. While the blooming season in 1920 as has been stated, was from two to three months, in 1921 peaches were through blooming in practically one month's time.

### Species

Nothing has been said that would indicate what species of thrips is responsible for the injury to peaches that has been described in this paper. At the present time a positive determination has not been made. The species very closely resembles the grain thrips, *Euthrips tritici* but some thrips experts who have examined material doubt that it is this species. There is a possibility of its being *Euthrips helianthi* according to Morgan of the U. S. Bureau of Entomology. Paul Jones, Entomologist for Balfour, Guthrie & Company, San Francisco, who has examined material, thinks that the species is *Euthrips tritici*, although he is not positive that it is. The writer inclines to the belief that *Euthrips helianthi* is the species which we have been dealing with in our peach orchards. It is a species that is very commonly found on sunflowers and last fall in fields where there were hundreds of acres of sunflowers in bloom, thrips occurred in large numbers in every blossom. It however, seems to be a general feeder and may be found in the blossom of alfalfa, Burr clover, Melilotus, mustard, and various other flowering plants.

The great damage which has been done during certain seasons by this species in both the Northern part of the state and the Southern deciduous fruit growing section, makes it a pest of first importance. The injury to peaches as it occurred in 1920 in the Ontario section is comparable to that of pears by pear thrips during a season of bad infestation. It is therefore important that some careful work be done on this insect to determine the species, its life habits and methods of control. At the present time we are not justified in stating that the ordinary methods which are used in the control of pear thrips will be a success in the control of peach thrips because the pest is so well protected during the entire time of its feeding on peaches.

## THE RESULTS OF USING CERTAIN OIL SPRAYS FOR THE CONTROL OF THE FRUIT TREE LEAF-ROLLER[1] IN THE PAJARO VALLEY, CALIFORNIA

By Donald D. Penny, *Watsonville, Calif.*

The fruit tree leaf-roller, in the Watsonville[2] apple district, continues each season to damage a certain amount of the fruit crop and while the infestation has never become such a serious menace as has been reported from some sections of the West, this insect does, however, do enough injury to render it a pest worthy of considerable attention.

[1] *Archips argyrospila* Walker.

[2] The city of Watsonville, California, is located on the coast about one hundred miles south of San Francisco, in the center of the Pajaro Valley. This valley contains approximately nineteen thousand acres of bearing apple orchards.

Oil spraying for leaf-roller control in the apple orchards of the Pajaro Valley during the past few years has been, at best, only partially successful. The more or less unsatisfactory results obtained were undoubtedly due to several factors, one of which, and in the writer's opinion, by far the most important, has been the use of oils not especially adapted to leaf-roller control.

Various workers along these lines have recommended, at different times, kerosene emulsion and miscible oil sprays. Indeed the splendid results obtained by Gillette and Weldon[3] in Colorado, by Leroy Childs[4] in Oregon and by B. B. Fulton[5] in Oregon would seem to indicate that the problem of leaf-roller control has been solved. In the Watsonville section, however, oil sprays that might be classified under the names of kerosene emulsion or miscible oils have given practically no control. It occured to the writer that the generally negative results obtained with these types of materials might possibly be due to the fact that the oils used may have been of the Western, or asphaltum, type rather than the Eastern or paraffin type. Mr. George M. List[6] in reporting the results of the season's spraying in the Canyon City and Penrose districts of Colorado in 1919 states that a considerable difference was found between the killing qualities of a miscible oil prepared from a heavy paraffin base oil and a miscible oil prepared from an asphaltum base oil. With the idea of this difference in mind several tests of a few samples of both of these oils were conducted by the writer during the winter of 1920-1921 and it is with the results of these experiments that this paper chiefly deals.

The several oils used in the tests included a 42° Baumé crude oil direct from the wells of Pennsylvania, Gas oil, a distillate of 34° Baumé from the Pennsylvania crude oil and sold by the Standard Oil Company of New Jersey, a 24° Baumé California crude oil, Western Shell distillate of 38° Baumé, Calol Diesiel engine oil of 24° Baumé sold by the Standard Oil Company of California. In addition to these oils two commercially prepared emulsions were tested. These were Ortho Crude Oil Emulsion manufactured by the California Spray Chemical Company and Spramulsion sold by the Sherwin-Williams Company. Also included in the

[3]Gillette, C. P. and Weldon, Geo. P. 1912. The Fruit Tree Leaf-Roller in Colorado. Circular 5. Office of State Entomologist of Colorado. October 1912.

[4]Childs, Leroy. Entomological Investigations 1915. Report of the Hood River Branch for 1914-1915. Oregon Agricultural Experiment Station.

[5]Fulton, B. B., 1921. The Fruit Tree Leaf-Roller. Report on Progress of Investigations. Third Crop Pest and Horticultural Report, 1915-1920. Oregon Agricultural College Experiment Station, Jan. 1921.

[6]List, Geo. M., 1920. Fruit Tree Leaf-Roller, Archips argyrospila Walker. Circular 28. Eleventh Annual Report of the State Entomologist of Colorado for the year 1919-Aug. 1920.

table of results is a count from egg masses collected from an orchard sprayed in January 1919 with Miscible Oil No. 1, manufactured by Balfour Guthrie & Company. In regard to this latter test, however, the writer desires to explain that he cannot vouch for the quality of the work as it was purely a commercial job and was in no way under his direction nor was he present to witness any of the operation of spraying.

The writer's experiments, which for the most part were similar to those conducted by other workers along these lines, included the dipping of egg masses in various emulsions as well as the actual spraying in the field.

By referring to the accompaning tables the data obtained in counting the egg masses may be noted. The (a) figures represent the results of the kill obtained by dipping egg masses in emulsions and then incubating the eggs at about 27°C. Before placing the eggs in the incubator they were left exposed to the air for a period of fourteen days. The reason for dipping egg masses in the emulsions was to obtain thorough contact between the mass and the liquid, a factor which cannot be entirely controlled in actual spraying. Dipping also affords a simplified method of indicating, to a limited extent, the effects of the various strengths of the oils used.

The (b) figures represent the egg counts from the sprayed plots.

All of the emulsions prepared for the experiments contained 2.5% of cresol soap as the emulsifying agent, with the exception of one sample of the Pennsylvania crude oil which was emulsified by the California Spray Chemical Company using the same method that is employed in preparing the regular Ortho Crude Oil Emulsion. The cresol soap was prepared according to the following formula: creselic acid 5 pounds, fatty acid 5 pounds, sodium hydroxide 1.7 pounds.

The figures obtained from the Western Shell distillate plot serve very well for a check as the count from the actual check plot varied but little from these figures. In obtaining the counts from the eggs on the trees the method followed was to tag a number of egg masses on the trees of each plot just after spraying and to refer to these masses for the count when the hatch for the district was complete. This tagging prevented including egg masses that may have remained on the trees from the years previous. In each case when one or more eggs hatched in the mass it was considered as a hatch for the mass.

In arriving at the percentage of kill for the various oils a more accurate figure would obviously have been obtained if a greater number of egg masses had been used for the counts. However, in order to facilitate the work, this higher degree of accuracy was sacrificed for the reason that the total number of egg masses in any infestation in this district is relative-

ly small and consequently the eggs are very difficult to obtain in large numbers. The eggs are placed almost entirely on the extremities of the branches, on twigs usually not greater in diameter than an ordinary pencil. The writer has never observed an egg mass on the main trunks of trees in the Watsonville district and it is indeed rarely that the eggs can be found even on large branches. It is quite evident also that this position factor of the eggs has a direct bearing on the degree of killing efficiency that can be obtained, even with a well adapted material, because of the misses that unavoidably occur in spraying. Within the bounds of economy it is almost an impossibility to thoroughly wet the extremities, particularly if the trees be large. It might be added further that the comparatively small number of eggs deposited means a small number of worms, each of which is able to do its maximum amount of injury and any spray that tends to reduce the number of worms at all will correspondingly reduce the total amount of injury.

The best control obtained with any oils in the tests was procured with the emulsion of the Pennsylvania Gas Oil, 10 per cent of which gave an 80.9 per cent kill in the sprayed plot.

The results obtained by dipping eggs in three strengths of this same oil would seem to indicate that for spraying a 5 per cent dilution is a little too weak while a 15 per cent strength would possibly give a better kill on the trees than 10 per cent. It is the writer's opinion in this case, however, that a 10 per cent emulsion is sufficiently strong and that inefficiency in spraying accounts for the 19.1 per cent of eggs that were not killed.

The Pennsylvania crude oil in both types of emulsions gave very good killing results with the dipped masses in the 10 per cent and 15 per cent strengths. The same can be said of the Calol Diesiel Oil. The failure of the 10 per cent strength of these oils to kill the eggs on the trees is not easily explained, especially since the same strength in dipping was quite effective with all of them.

The emulsions of California distillate gave practically no control with any strength, the figures being about the same as the check for both dipped and sprayed egg masses.

The results obtained with Spra-mulsion on the trees were almost negligible and only fair results were obtained with the dipped masses.

The count of the eggs from the orchard sprayed with the Balfour Guthrie & Company's Miscible Oil No. 1 showed a very low percentage of kill, but as stated before, the writer is in no way responsible for the preparation or application of the spray in this orchard.

The Ortho brand of Western crude oil emulsion gave a 50 per cent kill on the trees sprayed with the customary 12 per cent strength of oil. The results obtained from both types of emulsions of the Western crude oil in the dipping experiments gave some rather interesting figures showing that the killing efficiency varied more or less directly with the percentage of oil in the mixtures. In regard to the figure of 97.7 per cent kill obtained with the 15 per cent Ortho crude oil sample it might be explained that all but one egg in one mass failed to hatch which would make the actual kill very close to 100 per cent. The results obtained with the 12 per cent crude oil sample on the trees were not entirely satisfactory, in spite of the fact that the number of cull apples was reduced to 9.92 per cent total injury as compared with a check of 26.9 per cent total fruit injury. The figures obtained from the masses dipped in 15 per cent strength would seem to indicate that this greater strength of oil is needed to obtain satisfactory results from spraying, especially since under the ideal killing conditions offered by the dipping method the strength of oil required was 15 per cent for good results. This is a point which will be carefully investigated during the coming season.

Crude oil emulsions are widely used in the apple orchards of the Pajaro Valley as general winter sprays, giving excellent results in the control of the many scale insects as well as numerous other resistant overwintering insect forms. In addition, these materials produce marked tree stimulation. For these reasons the continued use of crude oil emulsion is highly desirable on the part of many growers and it would undoubtedly become even more so if found effective in controlling leaf-rollers at a strength within the limits of reasonable costs.

| | Strength | Date | Unhatched | Hatched | Total | Kill |
|---|---|---|---|---|---|---|
| (a) | 5% Western crude oil-(Ortho) | | 22 | 29 | 51 | 43.1% |
| | 10% " " " " | | 31 | 14 | 45 | 68.8% |
| | 15% " " " " | | 44 | 1 | 45 | 97.7% |
| | Check | | 1 | 51 | 52 | 1.9% |
| (b) | 12% Western crude oil-(Ortho) | Feb. 3 | 30 | 30 | 60 | 50.0% |
| (a) | 5% Penn. crude oil (emulsified the same as Ortho) | | 45 | 2 | 47 | 95.7% |
| | 10% Penn. crude oil | | 46 | 0 | 46 | 100.0% |
| | 15% " " " | | 48 | 0 | 48 | 100.0% |
| (b) | 12% " " " | Jan. 11 | 10 | 17 | 27 | 37.0% |
| (a) | 5% Western crude oil | | 26 | 26 | 52 | 50.0% |
| | 10% " " " | | 38 | 5 | 43 | 88.3% |
| | 15% " " " | | 42 | 1 | 43 | 97.6% |
| | Check with 5% cresol soap | | 6 | 38 | 44 | 13.6% |
| (b) | 10% Western crude oil | — | — | — | — | — |
| (a) | 5% Penn. crude oil | | 34 | 17 | 51 | 66.6% |
| | 10% " " " | | 40 | 0 | 40 | 100.0% |
| | 15% " " " | | 48 | 0 | 48 | 100.0% |
| (b) | 10% " " " | Feb. 3 | 14 | 38 | 52 | 26.9% |
| (a) | 5% Western Shell distillate | | 7 | 44 | 51 | 13.7% |
| | 10% " " " | | 9 | 38 | 47 | 19.1% |
| | 15% " " " | | 6 | 43 | 49 | 12.2% |
| (b) | 10% " " " | Feb. 3 | 1 | 56 | 57 | 1.7% |

| | | | | | | |
|---|---|---|---|---|---|---|
| (a) | 5% Penn. Gas Oil | | 41 | 3 | 44 | 93.1% |
| | 10% " " " | | 44 | 0 | 44 | 100.0% |
| | 15% " " " | | 51 | 0 | 51 | 100.0% |
| (b) | 10% " " " | Feb. 3 | 51 | 12 | 63 | 80.9% |
| (a) | 5% Calol Diesiel Oil-Standard Oil Co. | | 24 | 22 | 46 | 52.1% |
| | 10% " " " " " " | | 50 | 3 | 53 | 94.3% |
| | 15% " " " " " " | | 52 | 0 | 52 | 100.0% |
| (b) | 10% " " " " " " | Feb. 8 | 19 | 48 | 67 | 28.3% |
| (a) | Spra-mulsion maximum strength recommended 1–10 | | 25 | 19 | 44 | 56.8% |
| (b) | Spra-mulsion maximum strength | Feb. 8 | 6 | 44 | 50 | 12.0% |
| (b) | Miscible Oil No. 1 Recommended strength (Balfour Guthrie & Co) | Jan. 1919 | 4 | 53 | 57 | 7.01% |

# SUMMARY OF LIFE HISTORY OF BEET LEAFHOPPER (EUTETTIX TENELLA BAKER)

By Henry H. P. Severin, Ph. D.,

*California Agricultural Experiment Station.*

According to Ball[1] the beet leafhopper (*Eutettix tenella* Baker) is a "single-brooded species." In his life history chart, Ball indicates that the adults make their appearance on beets in March and the nymphs are present from May to July in the San Joaquin Valley and from May to August in the Salinas Valley of California.

We[2,3] have published an account of the life history of the beet leafhopper and reared two broods out-of-doors in the fog belt district at Berkeley during 1918.

Stahl[4] bred two generations out-of-doors in the fog belt district at Spreckels, California and a third and even fourth brood were obtained in the greenhouse.

We determined the life history of the beet leafhopper at Manteca, situated in the Northern end of the San Joaquin Valley. A detailed study of the life history was started with the dark adults which wintered over in the cultivated area and the work with the successive generations was conducted during 1919-1920. No breeding experiments have been conducted on the plains and foothills to determine the number of broods, and we are assuming that the first pale green adults which invade the cultivated area represent the first or spring generation. After the first

[1]Ball, E. D., 1917. The Beet Leafhopper and the Curly Leaf Disease that it Transmits. Utah Agr. Exp. Sta., Bul. 155, pp. 1–56.

[2]Severin, H. H. P. 1919. THE BEET LEAFHOPPER. A Report on Investiga tions into its Occurrence in California. Facts About Sugar, VIII, No. 7, pp. 130-131. 134; No. 8, pp. 150-151; No. 9, pp. 170-171; No. 10, pp. 190-191; No. 11, pp. 210-211; No. 12, pp. 230-231; No. 13, 250, 255.

[3]Severin, H. H. P. 1919. Investigations of the Beet Leafhopper (*Eutettix tenella* Baker) in California. Jour. Econ. Ent., XII, No. 4, pp. 312-326.

flight of the pale green adults into the cultivated regions during 1919, the number of generations was again ascertained. Various phases of the life history determined in cages were checked up in the cultivated area and on the plains and foothills for a period of four years.

The egg period was determined twice during each month from February to October. The incubation periodss varied from 11–55 days, the shortest egg periods occuring from July to September. Eggs deposited from November 1 to January 15, failed to hatch or the nymphs died out-of-doors during the winter. The eggs do not develop without fertilization.

Temperature plays an important role on the duration of the egg period. The mean temperature was 8°F. higher in the case of an egg stage requiring 44 days and extending from the winter into the spring, than the incubation period of 28 days in the autumn. The low winter temperature and humidity prolong the egg period but the rate of development is increased during the spring, whereas the high early autumn temperature increases the rate of early embryonic development and results in a shorter egg stage even with a lowering of the temperature later in the fall.

The nymphal periods of the first brood varied from 23–37 days from April to October. The egg and nymphal periods varied from 37–99 days. During the winter a high mortality of the nymphs occurred which hatched from eggs deposited during September and October.

Stahl[4] experienced many difficulties in determining the maximum number of eggs deposited by a single female and records the deposition of 237 eggs by one female at Spreckels and 247 eggs by another female at Riverside. To determine the number of eggs which a single female of the first brood deposits during her life, a male and female were confined in a cage enclosing a sugar beet. The male acquired the winged stage on May 8 and the female on May 9. The eggs were allowed to hatch and the total number of nymphs removed from the cage would equal the egg-laying capacity providing all of the eggs hatched. A total of 328 nymphs were removed twice during each month from June 15 to August 16. The female died on November 20.

Four generations were bred from the dark females which wintered over in the cultivated area. After the flight of the first brood from the plains and foothills into the cultivated area, four more generations were bred or a total of five broods. The months of maximum emergence of the first to the fourth broods bred from the dark females which wintered over in

[4]Stahl, C. F., 1920. Studies on the Life History and Habits of the Beet Leafhopper. Jour Agr. Research, XX, No. 4, pp. 245-252.

the cultivated area correspond to the same months in which the second to the fifth generations were reared from the pale green leafhoppers as follows: June-July; July-August; September-October and October-November.

The minimum preoviposition period of the first brood adults required three days during July at a mean temperature of 80.3°F. The preoviposition period of the dark overwintering females varied from 3-4½ months, hence no eggs were deposited during the autumn. The following percentages of dark females collected during the winter on the Coast Range had fully developed eggs in the ovaries: December 4%; January 52-64% and February 86-99%.

The longevity of 60 males and 40 females of the spring brood collected on April 28, 1919 on the plains near the foothills of the Coast Range was determined in a cage out-of-doors and varied as follows: males, three months; females, four months. The longest adult life of four generations which were bred varied as follows:

| Brood | Males | Females. |
|---|---|---|
| First | 4 | 9–10 months. |
| Second | 4–11 | 5–12 months. |
| Third | 7½ | 11 months. |
| Fourth | 4 | 8 months. |

The longevity of the dark overwintering adults can be determined approximately under natural conditions. Dark specimens first make their appearance in August in the cultivated area and are abundant from September to November. The first marked reduction in the number of dark males occurred during December in both the cultivated area and on the plains and foothills and from February to March, males are very rarely taken. The length of adult life of the dark males is about four months. The first marked reduction in the number of dark females occurs during March and April. In all probability, the last dark females are at the end of their natural life by the time that the pasture vegetation becomes dry. It is doubtful whether any dark females which flew to the plains and foothills during the autumn, return to the cultivated area during the spring. The longevity of the dark overwintering females is about seven or eight months under natural conditions. It is evident that the longest adult life in cages, of four broods which were bred, is greatly prolonged and does not occur under natural conditions.

Light colored adults rarely winter over. Some specimens collected on the plains and foothills from October to January had mature eggs in the ovaries, while others like the dark females, winter over without depositing eggs during the autumn.

The dark males follow the females to the plains and foothills, mate during the autumn and die during the winter. During the spring, however, most of the first brood pale green males remain behind on the plains and foothills and probably die after the pasture vegetation becomes dry. After a flight had occurred during the spring, 8% of the specimens collected in the cultivated area were males and 92% were females. After the invasion of the spring brood into the cultivated area 92% of the females had mature eggs in the ovaries.

## OBSERVATIONS ON THE BIOLOGY OF APPLE APHIDS

By Frank H. Lathrop, *Associate Entomologist*
*Oregon Agricultural Experiment Station*

It not infrequently happens that methods of treatment which have been used with great success in the control of insect pests in one section of the country prove inadequate when applied in some more or less distant section. Moreover, certain treatments, such as oil sprays, which are used with comparative safety in one section, may be too injurious to permit of their general use in another section or under different climatic conditions. These apparent discrepancies may usually be explained upon the basis of variation in behavior of the insect pests or of the orchard trees in reacting to the dissimilar conditions of climate, topography, or other environmental conditions of the two regions.

It is therefore desirable, in the study of insect pests, to compare, whenever possible, the characteristic behavior of the insects in different sections of the country.

During the seasons of 1915 and 1916, the writer had opportunity to study, at the Geneva Station in Western New York, the three species of aphids, (*Aphis avenae* Fab., *Aphis pomi* De G., and *Aphis sorbi* Kalt) which are commonly injurious in apple orchards. Since 1917 these observations have been continued in Western Oregon. This study, made in districts so widely separated and so distinctly different in climate, has brought out several interesting facts relative to the behavior of these insects.

### Relative Abundance of the Species

Probably the first difference to be noted is the relative abundance of the several species in the two regions.

In western New York, *Aphis avenae* is normally the most abundant of the three species. Although the actual injury from this species is

slight because of its low toxicity upon apple, the species, nevertheless, produces a heavy and conspicuous infestation, especially upon the blossom clusters, where it occurs in enormous numbers.

In the fruit districts of the Willamette Valley, Oregon, this species is rare upon apple, and each spring a thorough search has been necessary in order to find even a single colony in any of the orchards in which examinations were made. Apparently this same condition applies in California.[1] However, the species occurs more or less commonly on grains and grasses in both Oregon and California. This seems to indicate that the species is not conspicuous as an apple pest in regions where the climate permits wintering on grains or grasses.

Next to *Aphis avenae*, *A. pomi* is the most abundant in apple orchards of Western New York. The species increases in abundance during midsummer and young plantings as well as the more succulent portions of mature trees frequently suffer severe injury.

In Western Oregon, *Aphis pomi* is by no means uncommon, but severe injury from this species is not of frequent occurrence. The greatest abundance occurs in early summer; later in the season, infestation usually subsides to a minimum.

*Aphis sorbi* is by far the most common species in Western Oregon, while in Western New York, it is ordinarily the least numerous of the three. Because of the high toxicity of this species upon apple, and because of its habit of malforming the fruit, this is a serious pest wherever it occurs. The great abundance of this species under normal conditions in Western Oregon ranks this insect with the codling moth as one of the major pests of the apple.

## Hatching

Spring advances rapidly in Western New York with a proportionally rapid hatching of the eggs of the aphids under consideration. The gradual approach of spring in Western Oregon is accompanied by a long hatching period. There is a corresponding and even more striking prolongation of the intervals between the hatching periods of the several species.

During the spring of 1916 *Aphis avenae* began hatching in the locality of Geneva, N. Y. on April 22; *A. pomi* on April 26, a difference of four days. *A. sorbi* was intermediate between these two, but there was so little difference in time that the hatching of the two species appeared to occur almost simultaneously. Baker and Turner,[2] working at Vienna,

[1] Swain, Albert F., A Synopsis of the Aphididae of California, University of California, Tech. Bul., Vol. 3, No. 1, pp. 94, 95, 1919.

Virginia in 1915, observed a difference of eleven days between the beginning of the hatching period of *A. avenae* and that of *A. pomi*. Peterson[3] studying these species in New Jersey in 1919 observed a difference of fifteen days between the beginning of the hatching periods.

In Western Oregon, the hatching of *Aphis pomi* begins from nine to fifteen days later than *A. sorbi*. The extreme scarcity of *A. avenae* in the orchards under observation here has made it impossible to determine the exact date of hatching; however, it occurs, certainly from ten to fifteen days prior to the hatching of *A. sorbi*. This makes an interval of from nineteen to thirty days between the hatching of *A. avenae* and *A. pomi*.

The length of the hatching period shows a similar regional variation. Baker and Turner record a period of seventeen days between the hatching of the first and last eggs of *A. pomi* in Virginia. At Geneva, N. Y.[4] in 1916, hatching began on April 26 and was completed by May 2, a period of six days. At Corvallis, Oregon, in 1921, the eggs upon one tree under observation began hatching March 20, and continued to hatch until April 18, a period of twenty-nine days.

## Summer Activities

The most pronounced regional difference noted in the behavior of these aphis during the summer months occurred in the time of appearance of the winged forms.

At Geneva, N. Y., in 1916 the second generation of *Aphis avenae* consisted entirely of winged individuals, and the species quickly disappeared from the apple. Baker and Turner,[5] reported 98.1 per cent of the second generation winged at Vienna, Virginia in 1915. At Corvallis, Oregon, in 1919 the wingless forms were very few in the second generation. They became predominant in the fourth generation.

*Aphis sorbi* shows a tendency in this same direction, which accounts to some extent for the more serious nature of the pest under Western Oregon conditions.

During the summer of 1919, specimens of *A. sorbi* were placed on a young apple tree enclosed in a cheesecloth cage. This cage was kept constantly moist, thus reducing the temperature, raising the relative humidity, and inducing the tree to continue a rapid and succulent growth.

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[2]Baker, A. C. and Turner, W. F., Morphology and Biology of the Green Apple Aphis *In* Jour. Agr. Research, V, pp. 955-993, 1916.

[3]Peterson, Alvah, Response of the Eggs of *Aphis avenae* Fab. and *Aphis pomi* De G. to Various Sprays. *In* Jour. Econ. Ent., XII, pp. 363-386, 1919.

[4]Parrott, P. J., Hodgkiss, H. E., Lathrop, F. H., N. Y. Agr. Exp. Sta. Bul. 431, p. 40, 1917.

[5]Baker, A. C. and Turner, W. F., Apple-Grain aphis, In Jour. Agr. Research, XVIII pp. 311-324, 1919.

The wingless viviparous females were produced throughout the summer and were present until killed by frost in late November. So far as could be determined, there was no tendency to produce oviparous forms in the fall, and there was no indication that the species could maintain its existence upon apple for more than one season without the aid of the plantain forms.

*Aphis pomi* also shows a regional difference in the production of winged forms. Baker and Turner found that "in the second generation, the winged form outnumbers the wingless" in Virginia. During the spring of 1916, the writer observed colonies at Geneva, N. Y. in which at least ninety per cent of the second generation developed wings. This high percentage of winged forms in the second generation seems characteristic of *A. pomi* under Eastern climatic conditions. The scarcity of winged forms of later generations is equally characteristic.

Observations in Western Oregon show that there is much less tendency to thus segregate the development of winged forms. In this section, winged forms are usually not numerous in the second generation. Here the migratory forms are much more numerous in the later generations than is the case in the East.

## Winter Activities

The hibernation of *Aphis pomi* as observed in Oregon shows no conspicuous variation from the behavior of the species elsewhere.

*Aphis avenae* in Western Oregon winters principally as viviparous females on grains and grasses, where growth and reproduction take place during the winter months when the temperature permits. Comparatively few migrants appear on the apple in the fall and hibernation in the egg stage on apple is uncommon.

*Aphis sorbi* in Western Oregon produces numerous migrants which return to the apple in the fall, and are normally sufficient to produce a severe infestation. However, in this section, only a portion of the plantain forms become winged in the fall. A considerable percentage remain on plantain throughout the winter months. Reproduction and growth continue during the winter, although reduced to a very low rate. Specimens born in the insectary at Corvallis, November 27, matured February 10— a developmental period of seventy-four days.

Wintering on plantain is apparently normal with this species in the climate of the Willamette Valley, for infestation has been observed in the field throughout every winter since 1917. During the winter of 1919–20, *Aphis sorbi* on plantain in the field, where protected by snow, withstood a temperature of thirteen degrees below zero. Where there is no pro-

tection, the species succumbs to a much less vigorous temperature.

With the approach of spring, the overwintering forms on plantain become more active, and winged forms are produced to spread the infestation.

### Economic Considerations

The effects of regional variation in the behavior of apple aphids are of direct significance to the commercial fruit grower. The more severe injury to apple orchards normally resulting from attacks of *Aphis sorbi* in Western Oregon, makes the control of this pest in this section even more imperative than in regions where injury is less pronounced.

As a rule, *Aphis pomi* is less injurious in orchards of Western Oregon than in the New York fruit districts, and in normal seasons causes the Western Oregon orchardist little concern.

*Aphis avenae* is of no importance as an apple pest in Western Oregon.

By wintering on plantain, *Aphis sorbi* becomes independent of apple in Western Oregon. The continuous breeding on plantain produces a source of supply of these insects, which serves as a reservoir for the species, and which accounts in part for the greater infestation of apples in this region. Any campaign which might be undertaken for the actual eradication of the species from Western Oregon would have to be waged against the plantain forms as well as the infestation on apple.

In Western Oregon the greater capacity of *Aphis pomi* for dispersal in the later generations would probably greatly interfere with the control of this species during seasons of unusual abundance.

The most unfortunate effect, however, of the regional variations noted is the failure of the standard "delayed dormant" treatment to successfully control *Aphis sorbi* in Western Oregon in spite of the success with which this treatment is applied in the East. The unsatisfactory results which are attending the use of the "delayed dormant" spray of nicotine sulphate for the control of *Aphis sorbi* in the Willamette Valley are probably due to the long-drawn-out hatching period more than to any other factor.

## LIFE HISTORY OF THE CODLING MOTH IN WALNUTS AT SANTA ANA, CALIFORNIA

By H. J. Quayle

### Life History

Wintering Larvae. The larvae winter in cocoons beneath the loose bark of walnut trees, in old pruning cuts, under bands, if such are present,

in trays and other places into which the larvae can squeeze for protection.

They are inactive in these cocoons until early spring, when they remodel their cocoons so as to furnish exit tubes for the moths.

Spring Brood of Pupae. On April 6th counts and estimates made in the field indicated that in the walnut, about 10% of the wintering larvae had pupated, while about 15% of those in the apple had pupated. On April 19th about 20% had pupated from walnut, and 30% from apple. The last pupation of this brood occurred on June 19 from walnut, and about 10 days earlier from apple. The length of this stage varies from 18 to 30 days.

Spring Brood of Moths. The first moths were seen in the field on April 24. The maximum emergence was about June 1st, and the last emergence record from the apple was June 20th, and from the walnut, June 30th.

## The First Generation

First Brood of Eggs. The first eggs observed in the field were on May 8th on pears, May 12th on apples, and May 14th on walnuts. The maximum number of eggs was present on apple about June 1st, and on walnuts about June 10th. It has been noted this year, as in other years, that eggs occur earlier on apple than on walnut, and that eggs of this brood continue to be deposited until early in July. The time of incubation ranges from 10 to 20 days.

First Brood of Larvae. The first eggs observed to hatch was on May 17th on apple. The peak of appearance of the larvae on walnut was during the 2nd week of June. A large majority of the first-brood larvae enter, or attempt to enter at the calyx end of the nut. Before all of this brood enter, however, the nut becomes too hard (3rd week of June) at the calyx end and entrance is sought at other points, particularly where two nuts are in contact. The time spent in the nuts will average about 35 days. Some of this brood of larvae were still in the nuts 69 days after entrance, and even then showed no signs of spinning until they were disturbed by cracking the nuts. Such records were noted on August 18th and an occasional larva of this brood pass the winter before transforming. Definite records to this effect have been noted at Carpinteria and Santa Ana.

First Brood of Pupae. The first pupation of larvae that had hatched in the spring was observed on June 15th. The majority of this

brood pupated during the latter half of July. The period spent in the cocoon varied from 6 days to several weeks, but most of the specimens transferred in 10 to 12 days.

First Brood of Moths. Moths from eggs laid in the spring begin to appear on June 25th, maximum July 30, last September 1st, or later. Moths from the spring brood are still present at this date, so that there begins an overlapping of broods that persists and becomes more pronounced as the season advances. In fact, the overlapping may continue into the following season, since larvae of two or three different broods may pass the winter together.

The data given for the first observed appearance of the eggs, larvae, pupae and adults, are not necessarily for the same insect, nor do they represent the first actual appearance of the different stages, but only the "observed" appearance. For example, the moth that emerged on June 25th pupated earlier than June 20th, the date of the first observed pupation. The maximum emergence of this brood occurred about July 30th. The length of life of the moth varies from 5 to 18 days, the males dying much earlier than the females.

## The Second Generation

Second Brood of Eggs. The first eggs of the second brood were seen on July 3rd. During the last week of June and the first two weeks of July, while occasional eggs were deposited, egg laying was at a minimum during this period. Beginning the third week of July, eggs became more numerous and the peak of egg laying by this brood was during the first week of August.

Second Brood Larvae. Second brood larvae began to appear early in July and reached their maximum numbers about the second week of August. One larva which hatched on June 30, pupated on August 18, which represented the shortest larval life observed, 20 days. Under the heading "*First Brood Larvae*" a record was given of 69 days in the larval stage in summer and even at the end of this period, spinning seemed to be induced only by disturbance. Many of the second brood larvae pass the winter as such, and do not complete their development until the following year.

Second Brood Pupae and Moths. Some of the second brood larvae transform to the pupa and adult, the first of which may appear the last week of August and continue to appear until October.

## The Third Generation

Third Brood of Eggs and Larvae. Eggs and young larvae of this partial brood, appear in September and October. Recently hatched larvae have been observed to enter the nuts as late as the second week in October. When the nuts are harvested, while most of the larvae are mature, many will be found in various stages of development.

## Seasonal Life History at Santa Ana

The wintering larvae in their cocoons began to change to the pupae late in March and continue to pupate until the middle of June. The first moths appear during the middle of April, the peak of emergence occurs about June 1st, and the last of the brood emerges. The peak of egg laying by this spring brood of moths occurs the first week or two of June, while the first week of May and the first week of August represent respectively, the beginning and end of the brood. The peak of the appearance of the larvae occurs about June 10, while May 15 and July 15 represent respectively the beginning and end of the brood. The peak of the appearance of the moths of the first brood occurs the first week of August. Second brood eggs appear in maximum numbers August 10th. Second brood larvae second week of August, and second brood moths the last week of August. Eggs and larvae of the third generation appear in September and October. The wintering larvae include those of the first second and third broods. Since a few larvae of the first brood showed no indication of spinning until disturbed on August 18, 69 days after hatching, as well as other records, indicate that some of the larvae of the first brood do not transform until the following year. There is but one full brood and a partial second and third brood of eggs and larvae. Since, however, larvae of the first, second and third broods overwinter, there is left but one complete generation of the insect with a partial second and third.

## Seasonal History at Carpinteria

While an occasional specimen will appear at Carpinteria almost as early as at Santa Ana, the great majority appear much later at Carpinteria. In 1919 the peak of appearance of the spring brood of larvae was during the first and second weeks of July. In 1920, a warm spring, the peak occurred about the third week in June. There is only a partial second brood of larvae at Carpinteria and no third brood, so far as observed. At Santa Ana the greatest amount of injury is done by the second brood larvae in late July, August, and early September, while at Carpinteria the greatest injury is done by the spring brood during the

latter part of June, July and August. Nuts containing the spring brood larvae were collected in July, and while some of the larvae transformed to the adult, some remained in their cocoons throughout the season and the following winter. There is thus only one complete generation of the insect at Carpinteria and a partial second.

## COLD STORAGE CONTROL OF INSECTS

By E. R. De Ong, *University of California.*

The thought of insect control in stored products is usually associated with a gross infestation followed by a hasty attempt to kill all insects present by fumigation or other means. Such practice implies a certain amount of injury by insect feeding, but this in itself may be small compared with the loss from impaired appearance and the resulting prejudice of the purchaser of such infested packages, irrespective of whether or not the insects present are alive or dead. And the higher the plane upon which a specific brand rests, by reason of expensive advertising, the greater will be its fall, if that brand becomes the symbol for "worm eaten" goods. After the injury has been accomplished, the killing of the destructive insect cannot replace the loss in weight, remove the frass and webbing or restore the damaged fiber; neither is reinfestation prevented by fumigation or heat, no matter how carefully the work is done. Prevention is needed rather than cure, – we want insurance against all loss by insects and if fungi and bacteria can be included, the greater the value of the treatment and this is what cold storage may accomplish.

A cooperative experiment between the California Associated Raisin Co. and the University of California has been completed, wherein raisins were stored from four to five months at temperatures ranging from 10° to 48° F. The summary of the report for the entire storage period as made by the technical expert of the Association is a follows:

"It would seem from the foregoing that keeping raisins in cold storage at all temperatures of 10° to 48° F. will prevent infestation, but does not prevent sugaring, but the lower the temperature at which raisins are stored the less they are sugared."

"Also that raisins brought from any degree of cold storage to 50°F for 36 hours and then to 70° F. are in a slightly better condition than those brought directly from cold storage to 70° F. temperature".

"All of these samples were in good merchantable condition, there being no fermentation, insects, or mould present."

It is well known that at a low, constant, temperature insects are dormant and the prolonged exposure at a still lower degree may cause death,

which state may be reached even more quickly by sudden alternations from low to high and the reverse. Experiments, to secure definite data of this nature, were conducted on the different stages of the insects commonly attacking dried fruit, viz., *Plodia interpunctella* Hubn. (Indian meal moth), *Carpophilus hemipterus* Linn. (dried fruit beetle), *Silvanus surinamensis* (saw toothed grain beetle), *Tenebrioides mauritanicus* Linn. (cadelle) and *Carpoglyphus passularum* Hering. (dried fruit mite). No eggs were available at this time so this part of the work remains to be completed. Dried prunes, raisins and figs, infested with the above mentioned insects, were placed (just as they came from the storeroom packed in 50 pound boxes) in the experimental storage plant where the daily variation in temperature is less than one degree. The temperature in the different rooms being 10°, 25°, 32°, 36° and 45° to 50° F. Every thirty days one or two boxes of fruit were removed, their contents examined, and a count made of all insects found and their condition noted. Dead specimens were discarded to prevent their being counted the second time, if it became necessary to make a count in this box in the future. It was thought that this plan would better simulate conditions under practical operations rather than to place a counted number of insects in an artifically prepared feeding place. The total number of dead and living specimens was then taken as the basis for determining the percentage in the table. The total number of specimens in each species was not always as large as desired and as a consequence the curve is not as symmetrical as it would otherwise be. A summary of the data as given in Tables I and II does not distinguish between larva, pupa, and adults, but in the original record the variation between the stages was not great, the mature form of the larva of both beetles and moths seemed to be the most resistant of any. The few mature caterpillars which attempted to pupate during the storage period invariably died.

TABLE I MORTALITY RATE BY TEMPERATURE
(Summary of all species)[1]

| Length of Exposure | 10°F. % | 25°F. %. | 32°F. % | 36°F. % | 45-50° F % |
|---|---|---|---|---|---|
| 1 month | 100 | 98.7 | 80.6 | 86.5 | 0 |
| 2 months | -- | 99 | 88 | 100 | 0 |
| 3 months | 100 | 100 | 100 | 100 | 83 |
| 4 months | 100 | 100 | 100 | 100 | 85.8 |
| Mites 4 months | 100 | 42 | 45 | -- | 3 |

TABLE II MORTALITY RATE BY SPECIES
(Summary of Temperature Record)

| Name of Insect | One Month % | Two Months % | Three Months % | Four Months % |
|---|---|---|---|---|
| Plodia interpunctella | 72.4 | 77.1 | 91.8 | 62.5 |
| Carpophilus hemipterus | 76.0 | 100 | 100 | 100 |
| Silvanus surinamensis | 41.0 | 87.3 | 100 | 100 |
| Tenebrioides mauritanicus | — | — | — | 100 |
| Carpoglyphus passularum | — | — | — | 72 |

[1]Total number of specimens observed. *C. hemipterus* 294, *S. surinamensis* 1133, *T. mauritanicus* 35, *P. interpunctello* 404, *C. passularum* 3909 (estimate).

[2]The irregularity is explained by the fact that only 40 specimens were found at this examination, 15 of which were larvae in the room 45°-50° F.

From this data, it will be seen that a constant exposure of three months or more at any degree from 10° to 36° F. has proven fatal to the three stages of all insects experimented upon; two years prior to this a somewhat similar experiment was conducted with a total mortality rate of 96.5% in the third month and 100% in the fourth month. It may be concluded then, that dried fruit stored at any temperature from 10° to 36° F. will be free from all injury by insects during the time of storage and when removed at the end of the third or fourth month all stages of the insects experimented upon (unless it be the egg) would be dead. The action of bacteria and fungi would also apparently be suspended during the time of storage. A temperature of 45° – 50° F. causes dormancy, but only a low mortality.

Such a plan for handling dried fruit would give protection during the summer months, when practically all the loss occurs, so that hold-over stocks for use during the summer or speculative material that was being stored until another year could be held without risk of loss by insects. Stocks remaining in storage for three or four months would be practically sterile, from the insect standpoint, when removed. This is not a new principle, but an application to a field where it has not been commonly practiced. The dealers in furs have long used cold storage as a summer protection for their stocks and in 1907 Circular No 36, of the U. S. Bureau of Entomology was issued by C. L. Marlott, giving temperatures at which the activities of the clothes moth are checked but he speaks of mortality only with alternating temperatures.

The practical application of cold storage must include the comparative cost of chilled and normal temperatures (dry storage). A comparison of the rates as established by the California railroad commission shows a range in price per ton, for a season of 6 months as follows:

Cold storage–75c. to $1.00 per cwt. for 6 months season

Dry " (including labor) 11.1c. to 23.9c. per cwt. for 6 months season.

This is an average of 70 cents per cwt. or .7 of a cwt. per pound excess charge for cold storage. When the average retail price of dried fruit ranges from 20 to 30 cents per pound then the seasons insurance cost is from 2.3% to 3.5% of the value, and this cost will seldom be paid on any of the stock sold during the winter following the production of the fruit. Comparing this with the cost of insect protection during the growing season, we find that pear growers estimate the cost of one spraying as equivalent to 2 to 3% of the crop value with from three to six applica-

tions necessary, making a total protective cost of 6% -18% of the crop value. To summarize the insurance cost of the two periods, it is seen that:

Crop Protection during the growing season requires 6% – 18% of the crop value.

Crop Protection during the storage period is but 2.3% –3.5% of the crop value.

## FOREST INSECT PROBLEMS OF THE PACIFIC SLOPE

By A. J. Jaenicke, *Forest Examiner,*
*United States Forest Service, Portland, Oregon*

Until very recently only fire protection was given serious consideration whenever forest protection matters were under discussion. The term forest protection meant protection against fire and only fire. Gradually, however, there has been an awakening, and today many of the owners of timberland on the Pacific Coast are convinced that at least in the pine stands, the Dendroctonus beetle menace is as great, if not greater, than the hazard of forest destruction by fire. This awakening has come because of the gradual increase in value of the remaining timber and the resultant more careful attention which is given its protection. The damage caused by the always spectacular forest fire is easy for everyone to see and understand, but many observant foresters and even observant entomologists fail to recognize the slower and yet more insidious losses which the bark-beetles bring about in our forests. The Forest Service has long realized the necessity for forest insect control but thus far the funds for such work on the National Forests have been inadequate.

For more than thirty years the federal Bureau of Entomology has investigated the character and extent of the damage caused by the Dendroctonus beetles to the forests of this country. The life histories of these tree-killing beetles have been worked out and methods of control have been developed by the Bureau which are of proven efficacy. The application of these control methods again and again has resulted in the protection of timber at a cost far within the limits of good business practise. Equipped with a knowledge of these control methods, both private and government agencies are now in a position to effectively protect privately and federally owned forests against bark beetle depredations if the necessary funds are at hand.

In British Columbia, Washington, Oregon and California the forest insect problem is most acute in the pine stands. Other species of trees are by no means immune but in the Pacific Coast region the destruction

to the pine timber far over shadows the insect loss prevailing in the other tree species. The major pine species involved in the Pacific Slope insect depredations are, in order of their importance: western yellow pine[1], sugar pine, western white pine and lodgepole pine. Only two species of Dendroctonus are of primary importance in the wholesale killing of these four species of pine; namely, the western pine beetle (*Dendroctonus brevicomis* Lec.) and the mountain pine beetle (*Dendroctonus monticolae* Hopk.). The western pine beetle infests only the western yellow pine while the mountain pine beetle kills with equal ease the four species of pine we have enumerated. Nevertheless the volume of western yellow pine killed in this region by *brevicomis* undoubtedly exceeds the total *monticolae* depredations in all the four species of pine under discussion.

Ordinarily one finds only relatively unimportant evidences of the activity of these two species of Dendroctonus in our yellow pine, sugar pine, white pine and lodgepole forests. Small and scattered attacks of this type are known as normal infestations and in the present intensity of forest protection no control work is done on such infestations. However, they should be carefully watched for any evidences of increase in the severity of the attacks. Occasionally the killing of trees by these two *Dendroctonus* beetles proceeds at an alarming rate and in such cases the prompt destruction of the beetles in the infested trees must be undertaken. These concentrated and heavy attacks are called epidemic infestations. Since existing epidemics have their origin in normal or endemic situations, it is not at all improbable that eventually, when forest protection becomes more intensive, the so-called normal infestation will come in for its share of control work.

It has been demonstrated that the safe control of epidemics is not a one year or even a two or three year matter. It is true that the effort is made to help the natural forces to break the force of the infestation by large scale control operations in the first year or two, but it is just as important that this initial control work be followed up by a certain amount of so-called maintenance work year after year. This maintenance work is inexpensive and serves to prevent the recurrence of the epidemic conditions. As our pine stands become more and more valuable, they will be divided into control units and a definite permanent plan of insect control will be worked out for each unit. In the Sierra National Forest, in California the Bureau of Entomology already has

[1]Western yellow pine –Pinus ponderosa
Sugar pine –Pinus lambertiana
Western white pine –Pinus monticola
Lodgepole pine –Pinus contorta

such a plan well under way, and in other parts of the Pacific Slope the initial outlining of control units of both private and government pine forests has already been completed.

Perhaps a single instance of the tremendous loss which the western pine beetle (*Dendroctonus brevicomis*) can inflict on the yellow pine of this region will suffice. One of the finest bodies of western yellow pine in the West is located in southern Oregon in the vicinity of Klamath Falls. It is a privately owned body of timber covering an acreage of about 600,000 acres and a volume of at least ten billion feet. Thirty million dollars is a conservative valuation of this property. During the past ten years the forest fire loss on this area amounted to only $15,000 because of the efficacy of the fire protection plan. During this same ten year period there has been a $3,000,000 loss for which the westtern pine beetle has been entirely responsible. In other words, during the last ten years the western pine beetle has killed ten per cent of the stand. This killing is still going on. A few of the private owners have attempted to control the beetle on their own lands but their work was futile because of the indifference of the owners of neighboring timber. Oregon has recently put a compulsory forest insect control law on its statute books and so the way has been paved to force the indifferent and careless timber owner into line. This particular body of privately owned yellow pine timber is surrounded by federally owned forests which are infested to the same degree as the private timber. As a consequence an effective control campaign must provide for the reduction of the beetle on the private and government lands simultaneously. An emergency appropriation bill has recently been introduced in both Houses of Congress which provides for the appropriation of the $150,000 which is deemed necessary for the wiping out of the beetle menace on the federal lands.

In British Columbia, the *Dendroctonous* infestations are being fought on a large scale on provincial, crown and grant lands. The timber owners of Oregon and California are becoming fully alert to the beetle danger. And it is probable that within the next few years, Congress will provide more money to enable those responsible for the protection of federal timber to fight the *Dendroctonus* epidemics in co-operation with the private owners. In the meantime, the splendid investigative work of the Bureau of Entomology on these forest insect problems must be financed on a better basis. Its handful of forest entomologists in the West have had the three-fold responsibility of giving advice in the field to timber owners and government officers, carrying on insect surveys over large areas and keeping under way their investigative work. Improvements

in control methods are being developed constantly at the Bureau's western experiment stations under the direction of Dr. A. D. Hopkins. These improvements mean cheaper protection and the investigative work which yields them should not be sacrificed. There is a real need for the study of forest insect problems by the state experiment stations. With the rapidly growing demand by the forest industry for advice on forest insect control, the necessity for the enlargement of the Bureau's personnel of forest entomologists and the need for the attention of the state experiment stations to the many still unsettled phases of the forest insect problem are already at hand.

## BIOLOGICAL NOTES ON DESMOCERUS, A GENUS OF ROUNDHEAD BORERS, THE SPECIES OF WHICH INFEST VARIOUS ELDERS

By H. E. Burke, *Specialist in Forest Entomology, Bureau of Entomology, U. S. Dept. of Agric.*

The Genus Desmocerus consists of four western and one eastern species. All bore in the pith and wood of living shrubs or trees of various species of elder (Sambucus). As some of the elders are used as ornamental shrubs or shade trees these insects which infest them are of interest as shade tree pests. Usually the stems mined by the borers do not die but sometimes they do and in any case the emergence holes made by the beetle cause unsightly scars in the bark and afford an easy entrance to wood destroying bacteria, fungi and ants.

In general the life cycle of Desmocerus is two years. Eggs are laid in crevices of the bark or around wounds and the larva does most of its boring in the pith of the stems. Lateral mines are made through the wood to the surface of the bark for throwing out borings and for the emergence of the adult. Pupation and the transformation to the adult take place during the second spring in a cell in the pith. The adults emerge about the time the elder is in bloom and may be found on the flowers or foliage. The best method of collecting them, however, is to cut into the stems just before the flowers open and take them from the pupal cells.

All of the species have been collected and studied to some extent by the writer. Special attention has been given to *cribripennis* and *californicus* because they occur in the Pacific region and because *californicus* causes damage to the blue berried elder which is a common dooryard shade tree in central California. Mr. R. D. Hartman of the Los Gatos Forest Insect Laboratory made a number of notes on the life history of *californicus* and Miss E. T. Armstrong of the Washington office collected most of the *auripennis* studied.

*D. palliatus* Forst.—Eastern states; both males and females blue except for basal third of elytra which is yellow; larva mines stems of common eastern elder (Sambucus canadensis); does not always kill the stem mined. At Brookland, D. C. a large larva was found in the pith at the base of a large stem on February 19, 1910, and an adult in a pupal cell in a similar position on May 19, 1913.

*D. cribripennis* Horn.—Washington, Oregon, California; both males and females dark green above, elytra with narrow orange margins; larva mines stems of the western red-berried elder (S. callicarpa), usually does not kill the stems mined; eggs are laid in crevices in the bark. The young larva upon hatching mines through the wood into the pith and up the pith until full grown. At irregular intervals lateral mines are made from the pith through the wood to the surface for throwing out borings, etc. When growth is completed the larva mines through the wood to the surface and then retreats back into the pith plugging the mine as it goes with shredded borings. After pupation and transformation take place the adult emerges through this mine. At Pialschie, King Co., Wash., pupation takes place in the spring and the adults emerge during April and May. Sometimes the young larvae will eat a large hole in the outer wood before entering the pith. Several larvae may live in one stem. The life cycle is two years.

*D. californicus* Horn.—California; male elytra bluish or purplish with distinct orange margins, female elytra velvety black or slaty with slight orange margins; larva mines stems of the blue berried elder(S. glauca) at lower elevations in the central coast regions of California; usually does not kill the stems mined; the adult feeds on the foliage. Common around Los Gatos, Palo Alto and Guadaloupe in Santa Clara County. Egg is 3.5mm. long, 1.25mm. in dia., white when first laid, turning to brownish white and reddish brown; oblong, pointed at both ends, points terminating in knobs; surface marked by heavy, longitudinal wavy ridges which do not always extend from end to end, connected by lighter transverse ridges which are more prominent toward the ends; surface between ridges marked by large pits.

The eggs are laid in the crevices of the bark, tucked under the bark at scars or in the wood where small branches have been broken off. They are fastened on with a shellac like substance. Upon hatching the larva enters the bark near the shell or wanders for some distance before entering. Usually it mines through wood and into the pith as soon as possible but sometimes when in large trunks it remains in the wood until growth is completed. As the mine proceeds the larva makes lateral mines to the surface at irregular intervals for the purpose of throwing out

borings and other debris. When growth is completed the larva bores out to the surface, retreats for several inches, plugging the mine with shredded borings and forming a pupal cell in the pith. The larval stage lasts for about two years. Pupation takes place from January to April. The pupal stage lasts for about one month and the young adult remains in the cell for several weeks before emerging. The first adult was found in the pupal cell on February 20 and in the field on April 12th. The egg stage lasts from thirty to forty days. In the laboratory the female lays from eight to twenty eggs. The last beetle collected in the field was taken on May 19th.

*D. piperi* Webb.—Idaho, Washington, Oregon; male elytra entirely orange, female elytra bluish green with narrow orange margins, smaller species, 15 to 20mm. long; mines stems of black berried elder (S. melanocarpa). At Bourne, Baker County, Oregon, on June 29, 1910, males and females were common on the foliage of shrubs which had just blossomed. Many pairs were copulating.

*D. auripennis* Chev.—California; male elytra entirely orange, female elytra with broad orange margins but always with a darker blue green or purple discal area which may vary in size from a mere spot to one half the area of the elytra; larger species, 23 to 28 mm. long; mines stems of the blue berried elder (S. glauca) at higher elevations in the Sierras. Medium and large larvae were taken in the pith of the bases of stems of bushes near Ellis Meadows, Sierra National Forest, on May 16, 1921, at an elevation of about 5500 feet. One of the large larva pupated May 31 but failed to transform. Adults were taken in numbers on the flowers and foliage during July and August, 1914 and 1915, along the Lincoln Highway in El Dorado County, at an elevation of from 5000 to 5500 feet. Plants at lower elevations did not appear to be infested. The life cycle is two years, half grown larvae being found in July.

In case of damage the trunks of the trees to be protected should be sprayed the first of June with the Craighead arsenate of lead-miscible oil emulsion or some other good ovicide.

## EUROPEAN CORN BORER CONFERENCE

Sandusky, Ohio and St. Thomas, Ontario, Canada, Sept. 15-17, 1921.

A meeting of entomologists and others interested was held at Sandusky, Ohio, Sept. 15, 1921, to consider the corn borer situation and to suggest a national policy. Dr. E. D. Ball presided and was relieved at some of the sessions by Dr. Herbert Osborn.

The sessions included comprehensive statements by the entomologists in charge of the various divisions of the Corn Borer investigations in the United States and Canada. W. R. Walton discussed the general situation and the object of the conference; D. J. Caffrey explained the experimental work being conducted by the U. S. Bureau of Entomology and the essential results obtained; L. H. Worthley reviewed the quarantine work and the value derived therefrom. Arthur Gibson discussed the situation in Canada; H. G. Crawford reviewed the significant facts brought out in the investigational work being conducted in Canada; L. S. McLaine reported on the scouting and quarantine operations in the Dominion. There followed a general discussion of the entire problem in which many of the conferees took part.

A committee was appointed to suggest recommendations as to the policy to be adopted in relation to national, state, local, and individual control. The committee (E. P. Felt, Chairman, Arthur Gibson, E. C. Cotton, W. P. Flint, J. J. Davis, R. W. Harned, and L. H. Worthley) submitted the following report which was adopted at the final session at St. Thomas, Ontario, Sept. 17, 1921.

### Report of Committee on Policy

Economic Status. This conference of official entomologists of the United States and Canada views with grave concern the extensive spread of the European Corn Borer in 1921 and recognizes this insect as a menace to the agriculture of North America. The invasion this season into northern Ohio constitutes an immediate danger to the great corn belt of the country.

The natural spread of the insect and its establishment over large areas makes extermination impossible and we therefore advise the adoption of a policy designed to check further spread so far as possible and to promote the speedy development of practical control measures.

It is also our opinion, considering the advance in technical entomological investigations bearing on the development of control measures and the many agencies now available for the distribution of this information and the assurance of intelligent and energetic response, together with cooperation from the corn growers of the country, that it will be possible to greatly mitigate the damages that would almost certainly result from the unrestricted spread of the insect.

National Policy. We unhesitatingly recommend the continuance of quarantine measures as a most effective means of checking further spread.

We respectfully recommend to the U. S. Federal Horticultural Board the adoption of a modified regional quarantine in New England on account of the complex conditions due to the development of two generations in that area and the consequent infestation of numerous plants and would suggest establishing a quarantine line not farther west than the Connecticut river.

We respectfully suggest that quarantine restrictions in infested areas, where the Corn Borer normally produces but one generation annually, be limited to corn, all sorghums, Sudan grass and broom corn.

We also respectfully recommend to the Dominion of Canada Department of Agriculture, the continuance of the present policy in regard to quarantine measures as a means of control.

We would recommend very careful scouting of areas adjacent to the western infested districts bordering on Lake Erie (both in the United States and Canada) in order to speedily determine the extent of the infestation, since this would assist in formulating quarantine restrictions and aid in determining the policy in relation to control measures.

It is suggested that scouting work in territory adjacent to the infested areas in New England and New York be continued to such an extent as to determine quarantine lines.

State and Provincial Policies. The closest possible cooperation in both quarantine and control work with federal authorities is urged.

State and Provincial quarantines should coincide with federal regulations.

The authorities in infested States and Provinces are urged to make financial provision for cooperative work since this may mean maximum participation on the part of the Federal Governments.

The attention of the State and Provincial officials is called to the desirability of utilizing the extension service and all publicity agencies in developing a proper attitude toward control of this pest and the importance of keeping the infestation in sparsely infested areas down to a practical minimum, particularly in strategic localities.

Investigations. It is understood that the U. S. Bureau of Entomology is now compiling a record of the history of this insect in European countries and it is hereby urged that this work be speedily completed and made available to American entomologists.

The recent great extension of the Corn Borer infestation and the need of the development of control measures in the immediate future leads us to urge the great practical importance of a close study of this insect, by North America entomologists, in various European countries in order that information thus obtained may be made available to the entomologists of America and by them applied to the solution of the numerous problems in relation to the control of this pest.

Inasmuch as all control work must of necessity be based upon exact knowledge of an insect, it is our opinion that facilities for investigational work and the introduction of parasites might be somewhat expanded.

The conference has noted with pleasure the close cooperation in both control and investigational work between the United States and Canadian officials.

Methods Found of Value in Control Work. Cut corn close to the ground and as early as practicable.

Ensile entire crop whenever possible and this should include all waste from canning factories.

Shred or cut cornstalks before feeding, since this kills many borers and promotes consumption of the fodder.

Uneaten cornstalks, including corn stover in field, lot or barn, or parts of stalks, should be completely plowed under or burned by May 15. Such material should not be used for bedding or thrown into the manure.

Fall plowing, especially early fall plowing, thoroughly done, kills many borers. Heavy rolling prior to plowing is suggested.

Burn weeds and grass in or near infested corn.

Early planted corn is most likely to become infested, consequently somewhat later planting usually results in relatively less injury.

The following were present: *Geo. G. Atwood, Dept. Farms and Markets, Albany, N. Y. *E. D. Ball, U. S. Dept. Agric., Washington, D. C., H. N. Bartley, U. S. Bur. Entomology, Silver Creek, N. Y., Erle G. Brewer, U. S. Bur. Entomology, Cambridge, Mass., *L. Caesar, Ontario Agricultural College, Guelph, Ontario, *D. J. Caffrey, U. S. Bureau of Entomology Arlington, Mass., *E. C. Cotton, State Dept. Agriculture, Columbus, O., *H. G. Crawford, Dominion Dept. Agric., Ottawa, Canada, C. R. Crosby, Cornell Univ. College of Agriculture, Ithaca, N. Y., *J. F. Cunningham, Ohio Farmer, Cleveland, O., *J. J. Davis, Purdue Univ. Agric. Expt. Sta., Lafayette, Ind., F. C. Fall, U. S. Bur. of Entomology, Stoneham, Mass., *Richard Faxon, State Dept. Agric., Elyria, O., *E. P. Felt, State Entomologist, Albany, N. Y., *F. A. Fenton, Iowa Agric. Expt. Sta., Ames, Iowa, W. P. Flint, State Nat. Hist. Survey, Urbana, Ill., *Arthur Gibson, Dominion Dept. Agric., Ottawa, Canada, *H. A. Gossard, Ohio Agric. Expt. Sta., Wooster, O., *R. W. Harned, Miss. Agric. College, Agricultural College, Miss., *J. S. Houser, Ohio Agric. Expt. Station, Wooster, O., P. A. Howell, U. S. Bureau Entomology, Berlin, N. H., L.L. Huber, Columbus, O., *M. B. Jimison, County Agric. Agent, Sandusky, O., *K. F. Kellerman, Federal Horticultural Board, Washington, D. C., W. H. Larrimer, U. S. Bureau of Entomology, West Lafayette, Ind., Floyd DeLashmutt, County Agric. Agent, Oak Harbor, O., *Russell Lord, Ohio State College of Agriculture, Columbus, O., L. S. McLaine, Dominion Dept. of Agric. Ottawa, Canada *E. W. Mendenhall, Bureau of Plant Industry, Columbus, O., *W. A. Orton, Federal Horticultural Board, Washington, D. C., *Herbert Osborn, Ohio State University, Columbus, O., *T. H. Parks, Ohio State University, Columbus, O., R. H. Pettit, Mich, Agric. College, E. Lansing, Mich., *Saul Phillips, U. S. Bureau Entomology, Cambridge, Mass., T. R. Richardson, U. S. Bur. Entomology, Albany, N. Y., G. A. Runner, U. S. Dept. Agric., Sandusky, O., *A. F. Satterthwait, U. S. Bur. Entomology, Webster Groves, Mo., *C. H. Sears, The Sears & Nicholas Canning Co., Chillicothe, O., *L. J. Tabor, State Dept. Agric., Columbus, O., R. A. Vickery, U. S. Bureau Entomology, Cambridge, Mass., *W. R. Walton, U. S. Bureau Entomology, Washington, D. C., *C. G. Woodbury, Bureau Raw Products Research, National Canners Assoc'n., Washington, D. C., *L. H. Worthley, U. S. Bur. Entomology, Cambridge, Ohio.

Those marked with an asterisk made the trip to Ontario Sept. 16-17, where an exellent opportunity was afforded to observe the ravages of the pest and to better form an opinion relative to the present and possible future status of the insect.

In Canada the party was joined by Dr. J. H. Grisdale, Deputy Minister of Agriculture of the Dominion of Canada and the following connected with the Dominion and Provincial Corn Borer Investigations, H. F. Hudson, W. N. Keenan, R. H. Painter, L. J. Simpson, and J. G. Spencer.

The secretary of the conference, J. J. Davis had the minutes of the meeting mimeographed and has a few extra copies which can be obtained as long as the supply lasts.

# JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

## OCTOBER, 1921

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations as far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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The American Association of Economic Entomologists was organized at Toronto, Can, August 29, 1889 by James Fletcher, A. J. Cook, John B. Smith, Charles J. S. Bethune, L. O. Howard, Clarence M. Weed, E. Baynes Reed, H. Garman and C. W. Hargitt, although the first annual meeting was held at Washington, D. C., November 12th. The facts regarding the organization of the Association appear to have been largely overlooked and attention is called to them at this time because the coming meeting at Toronto is the first gathering of official Entomologists of the United States and Canada as an organization in Canadian territory since that historic time and moreover it happens that the sessions will be held in the same city and in conjunction with two other well known, nation wide organizations, the Entomological Society of Ontario, which celebrated its jubilee in 1913 and the Entomological Society of America. Arrangements have been made for meetings of these three organizations, each with its respective field and yet so closely related one to the other, that it is difficult to define sharply the spheres of influence, since one of our most prominent Entomologists expressed himself years ago to the effect: that All Entomology is economic. This is literally true. The work of the economic Entomologists, while more obviously practical and of immediate advantage, is dependent to a very large degree upon the efforts of the systematist in defining genera and species, particularly the latter. The entomological meetings at Toronto may not be so largely attended as those held near the great centers of population yet they promise to be exceptionally interesting not only from the historic side but on account of the presumably unusually large percentage of leading Entomologists likely to be in attendance. The occasion offers another excellent opportunity for cementing anew the ties of good fellowship and cooperation along scientific lines, which have prevailed since the early days of entomological work.

# Current Notes

The annual meeting of the Alabama State Beekeepers Association was scheduled to be held at Montogomery on September 22.

Mr. W. E. Hoffman has been appointed instructor in economic entomology at the University of Minnesota, vice W. E. Cook, resigned.

The department of biology at Macdonald College has been divided, Professor William Lochhead retaining charge of the department of entomology and zoology.

The appropriation for the control of bee diseases in Florida is $10,000.00, this being exactly double the amount available for such work last year.

Professor T. Miyake, professor of zoology, Agricultural College, Imperial University of Tokyo, Japan, a well-known writer on entomological topics died February 2, 1921.

Mr. William Schaus, lepidopterist of the United States National museum, received the degree of Master of Arts, last June, from the University of Wisconsin.

Dr. Henry Fox who has assisted in control operations against the Japanese beetle at Riverton, N. J., has returned to college to resume his teaching duties.

Dr. Ira M. Hawley of the entomological department of Cornell University has been appointed professor of entomology and entomologist at the Utah College and Station.

Dr. Phillip Garman, New Haven, Conn., visited Philadelphia, and spent the week October 4-11, in studying the collections of Odonata at the Academy of Natural Sciences.

Mr. F. P. Ide, who was appointed temporary laboratory assistant, Entomological Branch, Canadian Department of Agriculture, during the summer months, resigned September 3, to continue his studies.

Mr. W. H. Goodwin who assisted the department of entomology of the Ohio Station during the summer months, has returned to his school duties at East Youngstown.

Mr P. R. Lowry, of Ohio State University, has been appointed assistant entomologist at the New Hampshire Station, vice. C. R. Cleveland, who has gone to De Pauw University.

Mr. H. M. Brundrett has been transferred from the Federal Horticultural Board to the Bureau of Entomology, and assigned to work on the ox warble at Herkimer, N.Y.

Mr. H. O. Woodworth, formerly horticultural commissioner of San Mateo County, California, has been appointed professor of entomology in the College of Agriculture in the University of the Philippines.

Mr. George Hopping has been appointed Insect Pests Investigator of the Entomological Branch, Canadian Department of Agriculture, and is attached to the Division of Forest Insects at Vernon, B. C.

Mr. R. L. Webster, formerly of the Iowa College and Station, who has just completed work at Cornell University for the degree of Ph.D., has been appointed entomologist of the North Dakota Station, beginning in August.

Mr. F. W. L. Sladen, Dominion Apiarist of Canada, was drowned off Duck Island near Kingston, on September 10. Mr. Sladen was formerly assistant entomologist in the Division of Entomology in charge of bee work, and is the author of many articles and a book on "The Humblebee."

Dr. Clarence H. Kennedy instructor in Entomology at the Ohio State University will remain for the present at that institution. In the April issue of this journal it was announced that he had been appointed instructor in Entomology at the University of Tennessee. This was an error and it is not known how the report originated.

The State Plant Board of Mississippi is issuing a quarterly bulletin modeled on much the same lines as that of the State Plant Board of Florida and the monthly bulletin of the California State Department of Agriculture. It is a welcome addition to entomological literature and is destined to fill an important place in the economic work of the country. The first number is dated April, 1921.

Dr. E. D. Ball has resigned as Professor of Zoology and Entomology at the Iowa Agricultural College and State Entomologist of Iowa, and as Assistant Secretary of Agriculture, to accept the permanent position of Director of Scientific work in the U. S. Department of Agriculture. He began his new duties October 1, 1921.

Mr. L. H. Worthley of the U. S. Bureau of Entomology, in charge of field experiments in controlling the European corn borer, Mr. J. G. Sanders, Director of the Bureau of Plant Industry, Harrisburg, Pa., and Mr. E. C. Cotton, Director of the Bureau of Plant Industry, Columbus, Ohio, visited the region infested by the European corn borer in Ontario during August.

Two short courses in beekeeping will be conducted in Colorado, by the College of Agriculture in co-operation with the United States Department of Agriculture. The first will be held at Fort Collins during the week of November 21, and the other at Grand Junction the following week. The instructors are Dr. E. F. Phillips, Geo. S. Demuth, Kenneth Hawkins, Wesley Foster and Frank Rauchfuss.

Announcement has been made of two short courses in beekeeping by the College of Agriculture, University of California, in co-operation with the United States Department of Agriculture. One will be held at some point in southern California during the week beginning December 5, and the other at Berkeley the following week. Dr. E. F. Phillips and Mr. Geo. S. Demuth are prominent among the instructors.

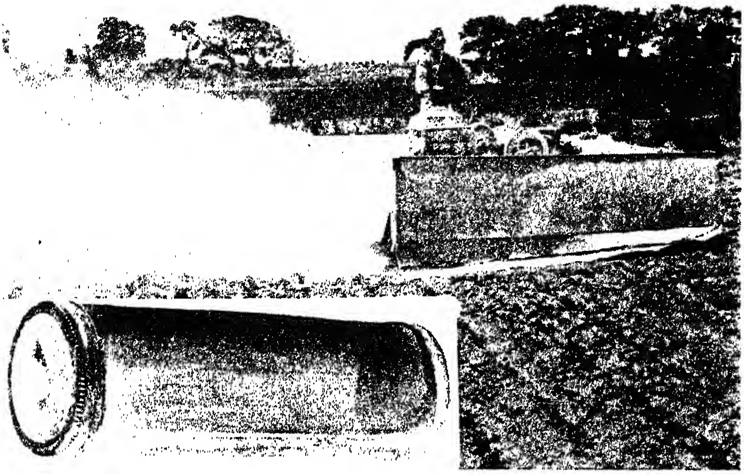
Mr. J. C. Bridwell, Bureau of Entomology, who left Washington last December for a study of the bruchid pests of the mesquite and closely related plants in Texas, returned from Brownsville to Washington during June with considerable parasitized material of *Acanthoscelides uniformis* and *Acanthoscelides sallaei*. Six hymenopterous parasites of these bruchids have been secured. Mr. Bridwell is at present preparing a report upon his work.

Mr. R. C. Treherne has been appointed Chief of the Division of Field Crop and Garden Insects of the Entomological Branch, Canadian Department of Agriculture, and will take up his duties at Ottawa in October. Mr. Treherne has been provincial entomologist for British Columbia, and was formerly connected with the central entomological work at Ottawa, when it was organized as a part of the Central Experimental Farms.

Mr. Dwight M. DeLong of the Bureau of Plant Industry, Harrisburg, Pa., has obtained a leave of absence and will teach elementary and economic entomology at the Ohio State University the coming year in place of Prof. C. L. Metcalf, who has recently gone to the University of Illinois. Mr. DeLong expects to receive his doctor's degree next spring and plans to return next summer to his work in Pennsylvania.

Professor M. D. Leonard has resigned as assistant professor of extension entomology at Cornell University to take effect November 1, 1921, to accept a position as field manager for the Bowker Insecticide Co., with headquarters at 49 Chambers St., New

PLATE 5.



York City. He will endeavor to make tests on the company's farms and in co-operation experiments with various growers of such materials as are now, or may be in the future, manufactured by the company.

The following men have recently been appointed to positions in the Bureau of Entomology:—W. W. Porter, Crowley, La.; Roland Cowart, Richard V. Hood, L. R. Lyle, George B. Ray, George L. Smith, W. A. Stevenson, Adolph Thomas, V. V. Williams, scientific assistants, boll weevil laboratory, Tallulah, La.; Ernest E. Russell, field superintendent in insect control, Gainesville, Texas; Dr. William Moore, formerly of the University of Minnesota to take charge of insecticide investigations against the Japanese beetle, Riverton, N. J.; W. E. Stone, sweet potato weevil work.

At the 31st annual meeting of the Ohio Academy of Science held at Cleveland, March 25-26, 1921, Prof. Raymond C. Osburn was elected President. The following entomological papers appeared on the program; Hemiptera of the Adirondacks; and Collecting in Southern Florida, by Herbert Osborn; Some Studies in Hessian Fly Emergence, by T. H. Parks; Notes on the Habits and Life History of *Galeatus peckhami* Ashm; and A New Ambrosia Beetle; Notes on the Work of *Xyloterinus politus* Say, by Carl J. Drake; Phylogeny and Distribution of the Genus *Libellula*, by Clarence H. Kennedy; Aids in Teaching Elementary Cytology, by Z. P. Metcalf; the Cytology of the Seaside Earwig, *Anisolabis*, by S. I. Kornhauser.

The following transfers in the Bureau of Entomology have been announced: R. T. Cotton, from Orlando, Fla., to Washington, D. C., Miss Marion Van Horn from truck crop insect investigations to stored product insect investigations; L. R. Lyle, G. B. Ray, I. B. Rutledge, G. L. Smith, W. A. Stevenson, J. V. Vernon, V. V. Williams temporarily from boll weevil force to Federal Horticultural Board; R. W. Wells, Herkimer, N. Y., to Dallas, Texas; S. H. Roundtree, Macclenny, Fla., to Brownsville, Fla; Perez Simmons to insects affecting meats; L. W. Brannon, H. B. Lancaster, D. M. Dowdell, Jr., F. R. White, bean beetle investigations, to plant quarantine inspectors in the same project; G. L. Garrision, Quincy, Fla., to Washington, D. C.

Resignations in the Bureau of Entomology are announced as follows:—J. B. Moorman, bee-culture investigations to accept a position at Austin College, Sherman, Texas; E. S. Prevost, So. Carolina, and N. I. Lyle, Iowa, extension specialists in bee-culture; A. D. Shaftsbury, bee culture investigations to resume graduate studies in zoology at Johns Hopkins University; Louis R. Schreiner, field assistant, Carlisle, Pa., to complete his studies; F. D. Parnell, W. R. Smith, boll weevil force; J. W. Hendry, sweet potato weevil work, Macclenny, Fla; L. M. Prichard, sweet potato weevil work, Gulfport; L. P. Hodges, Alexander G. McCarty, J. N. Crisler, S. N. Boyd, boll weevil force; the following temporary appointments have been terminated; W. R. Heard, J. B. Pope, H. C. Young, Tallulah, La., and Charles Milford, Madison, Fla.

Mr. J. S. Houser, co-operating with C. N. Nellie, Park Entomologist of Cleveland and the U. S. Aviation Service, of McCook Field, Dayton, August 4, conducted a dusting experiment at Troy, Ohio, on a six-acre catalpa grove which was being defoliated by the catalpa sphinx. The poison was delivered from an aeroplane and the six acres were dusted in 54 seconds. An examination made six days later, showed 99 per cent. of the caterpillars were killed. It is believed that this method of distributing poison will be found very useful for treatment of large, close planted forest areas for foliage-eating insects such as gipsy moth. It may be useful for treating large orchards of big pecan and walnut trees, but can hardly take the place of liquid spraying in apple and peach orchards.

Mr. H. F. Willard, Bureau of Entomolgy, who has charge of the Honolulu office of the Federal Horticultural Board, is investigating the bruchid pests of the lagaroba bean as his inspection duties permit. When he sailed from San Francisco, July 20, he carried with him several lots of pods of huisache (*Vachellia farnesiana*), secured by Bridwell, in which was breeding the huisache weevil (*Acanthoscelidessallaei*) and its parasites. Mr. Willard arrived in Honolulu July 27 and reported, on July 30, that the parasites, *Urosigalphus bruchi* and *Horismenus* sp. were emerging in good numbers on his arrival at Honolulu, and that between July 27 and 30 he had secured over 300 specimens of *Urosigalphus* and 1,000 specimens of *Horismenus* sp. On July 30, 94 females and 113 males of *U. brauchi* were liberated and immediately began searching algaroba pods for bruchid larvae. On August 7, Mr. Willard reports having reared from the Texas material, besides the two species mentioned above, *Glyptocolastes bruchivorus* and *Lariophagus texanus*. The work in Honolulu is being done by Mr. Willard in co-operation with D. T. Fullaway, entomologist of the Hawiian Board of Agriculture and Forestry.

The Mexican bean beetle caused larger losses this season than usual in the Estancia Valley in New Mexico. Reports by county agents and several growers show that about 5,000 acres of beans were totally destroyed, and the amount of damage is conservatively placed at $100,000.00. Reports by several of the growers and by Dr. Robert Middlebrook, entomologist of the State Agricultural College, State College, N. Mex., indicate that the insect was held in check to some extent by dipterous parasites. An investigation of this report was made, but it was too late in the season to determine absolutely whether a parasite had been at work. As a general rule, the Mexican bean beetle, in its occurrence in New Mexico, confines its attacks to the edges of the large plantings that lie close to the hills. During the present year severe damage resulted in the middle of the Estancia Valley, many miles from the mountains, and the bean growers are fearful lest the insect will repeat its attacks other years. The bean harvest in the West was almost completed by September 10 and many of the beetles were in the fields but none of them could be found in hibernation in the shrubbery in the foothills.

A hearing was held in Washington, D.C., on October 11, at 10:00 o'clock, A. M., before the Federal Horticultural Board to consider further steps necessary to prevent the spread of the European corn borer, which has been discovered this summer along the south shore of Lake Erie in Ohio and Pennsylvania, where it probably drifted from the infestation north of the lake in Ontario. The States of Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Ohio, Indiana, Michigan and Mississippi were represented. The following entomologists were present:–W. C. O'Kane, New Hampshire; R. H. Allen, Massachusetts; W. E. Britton, Connecticut; E. P. Felt, C. R. Crosby, New York, T. J. Headlee, C. H. Hadley, New Jersey; J. G. Sanders, Pennsylvania; E. N. Cory, T. B. Symons, C. C. Hamilton, Maryland; H. A. Gossard, E. C. Cotton, T. H. Parks, Ohio; F. N. Wallace, Indiana; R. H Lobdell, Mississippi; L. O. Howard, C. L. Marlatt, W. R. Walton, A. L. Quaintance, J. A. Hyslop, L. H. Worthley, D. J. Caffrey, E. H. Siegler and J. S. Wade of the Bureau of Entomology; Dr. E. D. Ball, Director of Scientific Research of the U. S. Department of Agriculture. There were between 50 and 60 present, including a number of plant growers, and representatives of State departments of agriculture; the writer did not keep a list of all, but noticed Prof. L. R. Taft, Michigan; Dr. G. G. Atwood, New York, Dr. A. W. Gilbert, Massachusets; L. H. Healey, F. E. Blakeman, Connecticut. The speakers were practically unanimous in asking that the present system of Federal quarantine be continued and extended as may be necessary to include the infested areas, but that no large uninfested territory be included in the quarantined areas.

# JOURNAL

OF

# ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 14 DECEMBER, 1921 No. 6

## FURTHER OBSERVATIONS ON THE EFFECT OF CERTAIN CHEMICALS UPON OVIPOSITION IN THE HOUSE FLY (*MUSCA DOMESTICA*.)

By S. E. CRUMB and S. C. LYON, *Bureau of Entomology*

In a previous article[1] dealing mainly with the effect of carbon dioxid and ammonia on house-fly oviposition, the writers described the general conditions under which the experiments discussed in the present article were continued during the summers of 1918 and 1919.

The substances used in the present series of experiments, however, are less volatile than those used in the previous ones and for this reason the writers dispensed with the compressed-air chambers previously described and placed the funnels bearing the oviposition medium over milk bottles one-third full of tap water. In these cases the attractant was applied in solution direct to the medium, which was bran husk washed and sterilized as before immediately previous to use. The checks used in all cases were treated in exactly the same manner, excepting that they received a corresponding volume of tap water instead of the solution of the attractant.

Ordinarily a row of 12 units of the foregoing apparatus was employed, the water-treated checks alternating with the attractant used at the time. Occasionally when the total number of flies in the cage was small, only six units, three of the check and three of the attractant, were used.

It seemed better to adopt a standard check against which to try all attractants than to endeavor to work out any scheme of checking by

[1]Crumb, S.E. and Lyon, S.C. The effect of certain chemicals upon oviposition in the house-fly (*Musca domestica* L.). In Journ. Econ. Ent., V.10, no.6, p.532–536, fig. 27. 1917.

trying one attractant against another. The results on different substances should therefore be directly comparable with one another.

In regard to strength of solutions of the different substances used, it should be stated that with the exception of sodium carbonate, sodium sulphate, and calcium hydroxid, they were made of approximately equal chemical strength; that is, the potential hydrogen ion or equivalent was the same in all cases, and equal to that in a 2 percent (by weight) solution of butyric acid. The two salt solutions, sodium carbonate and sodium sulphate were of the same molecular concentration as the butyric acid; that is, double the potential ionic strength. The calcium hydroxid solution was saturated at 20 C. The amount applied to each unit of nidus was from 2 to 4 cubic centimeters. Since the experimental work started with butyric acid, and when it was found that from 2 to 4 cubic centimeters of a 2 per cent solution of this attractant seemed most effective, additional substances were made up and applied on this basis.

In this way it has been possible to test out in a satisfactory manner 13 different substances in addition to carbon dioxid and ammonia; and it is believed that the results in these cases fairly express the oviposition responses of the house fly toward the substances used.

The Results of the 88 experiments made in the two seasons are summarized in Table I.

TABLE I. OVIPOSITION RESPONSE OF THE HOUSE FLY TO CERTAIN CHEMICALS

1918

| Inclusive dates | No. of Expts. | Attractant | No. units | Total eggs | Eggs per unit | Per-cent of total |
|---|---|---|---|---|---|---|
| June 20–July 3 | 11 | 2–4 cc. 2 percent Butyric acid | 50 | 9,377 | 187.9 | 73.5 |
| | | 2–4 cc. tap water | 50 | 3,373 | 67.4 | 26.5 |
| July 5–12 | 5 | 2 cc. 1.4 percent acetic acid | 30 | 3,055 | 101.8 | 83.8 |
| | | Tap water | 30 | 592 | 19.7 | 16.2 |
| July 15–20 | 5 | 2 cc. 1.1 percent Sulphuric Acid | 28 | 1,726 | 61.6 | 37.5 |
| | | Tap water | 28 | 2,877 | 102.7 | 62.5 |
| July 23–Aug. 3 | 8 | 2–4 cc. 1.05 percent Ethyl alcohol | 36 | 3,091 | 86.9 | 58.5 |
| | | Tap water | 36 | 2,234 | 62.1 | 41.5 |
| Aug. 6–21 | 6 | 2 cc. 0.62 percent Glycerin | 20 | 1,946 | 97.3 | 54.9 |
| | | Tap water | 20 | 1,601 | 80.1 | 45.1 |
| Aug. 22–Sept.4 | 7 | 2 cc. 0.83 Precent Hydrochloric acid | 42 | 2.065 | 49.2 | 44.8 |
| | | Tap water | 42 | 2,541 | 60.5 | 55.2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1919 | | | | | | |
| June 12–18 | 6 | 2–4 cc. 1.7 percent Propionic acid | 36 | 5,025 | 139.6 | 64.8 |
| | | Tap water | 36 | 2,744 | 76.2 | 35.2 |
| June 19–27 | 6 | 2–4 cc. 2.0 percent lactic acid | 33 | 1,035 | 31.3 | 46.3 |
| | | 2–4 cc. Tap water | 33 | 1,203 | 36.4 | 53.7 |
| June 30–July 7 | 7 | 2–4 cc. 1.0 percent formic acid | 42 | 2,183 | 52.0 | 66.7 |
| | | 2–4 cc. Tap water | 42 | 1,086 | 25.9 | 33.3 |
| July 8–14 | 6 | 2–4 cc. 0.176 percent calcium hydroxide | 36 | 1,618 | 45.0 | 42.8 |
| | | 2–4 cc. Tap water | 36 | 2,167 | 60.0 | 57.2 |
| July 15-23 | 6 | 2–4 cc. 1.0 percent sodium hydroxide | 36 | 3,575 | 99.0 | 75.8 |
| | | 2–4 cc. Tap water | 36 | 1,139 | 32.0 | 24.2 |
| July 24–Aug. 1 | 7 | 2–4 cc. 2.4 percent sodium carbonate | 39 | 2,998 | 77.0 | 94.2 |
| | | 2–4 Tap water | 39 | 185 | 4.7 | 5.8 |
| Aug. 4–15 | 8 | 2–4 cc. 3.2 percent Sodium | 42 | 582 | 12.4 | 69.6 |
| | | 2-4 cc. Tap water | 42 | 228 | 5.4 | 30.4 |

Since the dosages are equal and the chemical concentration of the different attractants is approximately the same, a better view of the comparative effect may be obtained by eliminating the checks, and listing the substances used with their corresponding percentages. Stated in this fashion and listed in the order of diminishing attractiveness the results appear as follows:

| | | Percent. |
|---|---|---|
| 1. | Sodium carbonate | 94.2 |
| 2. | Carbon dioxid (carbonic acid)[1] | 92.4 |
| 3. | Acetic acid | 83.8 |
| 4. | Sodium hydroxide | 75.8 |
| 5. | Butyric acid | 73.5 |
| 6. | Sodium sulphate | 69.6 |
| 7. | Formic acid | 66.7 |
| 8. | Propionic acid | 64.8 |
| 9. | Ethyl alcohol | 58.5 |
| 10. | Glycerin | 54.9 |
| 11. | Lactic acid | 46.3 |
| 12. | Hydrochloric acid | 44.8 |
| 13. | Calcium hydroxide | 42.8 |
| 14. | Sulphuric acid | 37.5 |
| 15. | Ammonia (ammonium hydroxid)[1] | 32.6 |

[1]Experiments carried on in 1917.

In the case of sodium carbonate, standing first, it is believed that the results obtained in 1917 with carbon dioxid have been confirmed. Since the results with the two substances are practically identical, the marked results obtained with sodium carbonate and its chemical kinship to carbon dioxid led to an investigation of the degree of acidity developing in the moistened bran bait during the 6-hour period of exposure. Additional similarly prepared check units were exposed but screened from the flies. Tested before exposure these units were neutral to phenolthalein. At the end of the 6-hour period of exposure they showed an acidity measured by the same indicator, practically equal to the alkalinity obtained by the dosage used in the sodium carbonate units. Thus it seems possible that a complete liberation of the carbonic acid present in the sodium carbonate units must have taken place, and that the presence of this free carbonic acid in the moist bran bait accounts for the fact that 94 percent of the eggs were obtained in these units. Hence the writers' conclusion that this is a confirmation of their former results with carbon dioxid.

Sodium hydroxid is also a moderate attractant, but, much as is the case with the sodium carbonate, the effect obtained is secondary to a chemical change which occurs in the course of the experiment. The sodium hydroxid doubtless rapidly absorbs carbon dioxid from the air, being converted into the carbonate, which in turn is acted on by the organic acid formed by fermentation in the moist bran medium. This sequence of changes would result in accumulation of a moderate amount of free carbonic acid in the bran medium as before. It will be noted that the calcium hydroxid solution proved of no effect in stimulating oviposition. As to why the same result was not obtained here as in the cases of sodium hydroxid and sodium carbonate it must be observed that the saturated solution of calcium hydroxid at 20 C. is approximately only a 0.176 percent solution and therefore less than one-sixth the equivalent chemical strength of the sodium hydroxid and carbonate solutions. Therefore the amount of carbon dioxid absorbed and converted into free carbonic acid in the acid bran nidus is probably negligible. In fact it is doubtful whether the same chemical change would occur in full, with even the same amount present, due to the relative insolubility of the calcium carbonate when formed.

In the case of sodium sulphate, a moderate attraction is to be observed. The results with this substance are the least satisfactory of the series however, on account of the relatively small number of eggs obtained, incident to weather conditions and inability to secure many gravid flies. Considering together, sodium sulphate, sodium carbonate, and

sodium hydroxid, the writers' conclude that the sodium ion is not a repellent to house-fly oviposition and its presence in some salt combinations may be moderately attractive.

Of the remaining substances[9] in the list receiving more than 60 percent of eggs, all are fatty acids and therefore chemically kin to carbonic acid. Of these acetic acid leads by a wide margin and it is worthy of note that this is the acid most likely to occur in the ordinary decomposition processes of vegetable matter where carbon dioxid is also liberated.

Gravid house flies appear to be indifferent to the presence of the organic bases, grain alcohol and glycerin, as might also be stated of the mixed compound lactic acid. The mineral acids, hydrochloric and sulphuric, appear to be moderate repellents.

In the light of present results the writers' suggest that the female house fly is attracted for egg laying by decaying organic matter in proportion to the amount of carbonic and acetic acids liberated in the fermentation processes, and that the preference for decaying vegetable rather than animal matter may have its explanation in this fact. Also it is possible that its predisposition for these two acids may explain the fondness of the house fly for human environments generally, particularly dwelling houses and livery stables.

## DUSTING VS. SPRAYING FOR THE CONTROL OF INSECT PESTS ON THE AVOCADO[1]

By G. F. MOZNETTE, *Bureau of Entomology, U. S. Department of Agriculture, Miami, Florida.*

The Avocado which is now being propagated quite extensively on a commercial scale in Florida has like all other fruits a number of injurious insect enemies. It is during the dry winter months particularly, while the trees are dormant that the grower of this fruit often experiences serious trouble with a number of enemies which attack his trees. Among these enemies may be mentioned the Avocado Red Spider, *Tetranychus yothersi* McGregor; the leaf thrips commonly called in the North the greenhouse thrips, *Heliothrips hemorrhoidalis* Bouche′ and the leaf hopper, *Empoasca minuenda* Ball. The red spider and the leaf thrips confine their attacks to the upper surface of the foliage, while the leaf hopper does its work on the lower surface.

During the seasons 1918 and 1919 a number of tests were made with a view to ascertaining the relative merits of several contact insecticides in the dust or powdered form alone and in combination, with similar contact

[1]Published by permission of the Secretary of Agriculture.

insecticides in the liquid form in the control of the above mentioned pests which attack the avocado. A portion of a large grove consisting mainly of the Trapp and Pollock avocados of West Indian strains, which were considerably infested with all the mentioned insect pests was selected for a comparison of the two methods.

In conducting the dusting operations the equipment used was the regular orchard power duster. At the time the applications were made the weather was clear and the foliage was dry. The temperature averaged between 75 and 80 degrees Fahrenheit. The dust was so directed on the windward side of the trees so as to cover the trees well, and the machine was never allowed to stop except at a large tree to be certain it was well covered.

The spraying work was performed the same day a power outfit being employed, using one of the spray guns at a pressure ranging from 225 to 250 pounds.

In the dusting experiments several kinds of material were used among which was an impalpable sulphur dust. This sulphur dust is nearly pure sulphur very finely pulverized and capable of going through a 200 mesh screen. The other material used was a combination consisting of the above dusting sulphur impregnated with a quantity of nicotine sulphate, 40% solution, in the form of Black Leaf-40. Both of these dusting materials are manufactured and on the market as contact dusting insecticides. In the spraying work several sprays were tried out in comparison with the above dusts as lime sulphur solution one gallon to fifty gallons of water, and lime sulphur solution at the rate of one gallon to fifty gallons of water in combination with Black Leaf-40 at the rate of one gallon to nine-hundred gallons in the diluted lime sulphur solution. A portion of a block was left as a check experiment.

Subsequent examinations at various intervals of the dusted and sprayed portions of the grove showed that the dusting method, where the dry dusting sulphur in an exceedingly pulverized form was used, to be equally as effective as spraying with lime sulphur solution against the avocado red spider, *Tetranychus yothersi* McGregor. The mites were not killed immediately, however, on the dusted trees, but after thirty minutes practically all the mites were killed. On examination of the foliage with a hand lens the sulphur was very evenly applied, no portion of the upper surface of the foliage being free from the fine sulphur. In the dusted portion of the grove with the dusting sulphur, the red spiders again made their appearance after a period of five weeks, which was also true approximately in the block where the lime sulphur

solution, one gallon to fifty gallons of water was applied. The weather following application of the dusts was rather dry although for several days following very heavy dews occurred which wet the foliage thoroughly, and a week later a heavy shower occurred in the grove. These heavy dews and shower had very little effect on the sulphur dusted trees in removing any of the dust. Where the lime sulphur solution was applied it killed the red spiders by contact almost immediately, and proved satisfactory in controlling the red spiders over as long a period as did the sulphur dust.

Where a large acreage of avocados exists, and the red spider is the only pest with which the grower has to contend, the dusting method would make it possible for the grower to protect his orchard at critical times from the attacks of the red spider. The dusting method is by far the quicker method.

There are other pests, however, with which the avocado grower has to contend with such as the leaf thrips, *Heliothrips hemorrhoidalis* Bouche' and the leaf hopper, *Empoasca minuenda* Ball. Neither the dry sulphur dust or the liquid lime sulphur had any effect in ridding the trees of the leaf thrips or the leaf hoppers. These two insects are usually present and causing damage to the trees at the same time generally that the red spider is carrying on its depredations, and which are not destroyed by applications of sulphur in the dust or liquid form. To possibly control these by the dusting method the writer procured a dusting material consisting of the finely pulverized sulphur dust charged with nicotine sulphate, 40% solution, in the form of Black Leaf-40. This material was dusted in the same manner as was the dry dusting sulphur. This combined material killed readily the adult and immature red spiders, leaf thrips and a good majority of the leaf hoppers. The material, however, did not adhere to the foliage for any length of time, even the heavy dews removing the majority of the dust. This apparently was due to the incorporation of the liquid nicotine sulphate to the dry pulverized sulphur causing the sulphur particles to aggregate and forming a wettable sulphur. In the case of the dry dusting sulphur, it is due to its fineness and dry condition when applied that it adheres so well to the foliage. The continued heavy dews and subsequent shower removed the majority of the combined dust from the foliage, and it was but a short time after application that the red spiders were again present on the trees in goodly numbers. This is readily explained as nothing effective remained on the foliage to destroy the young which later hatched from the eggs not destroyed by the dust. Hence it is essential, that

the dust remains on the foliage for a sufficient length of time after application in order to destroy the young mites as they hatch from the eggs.

In combining the lime sulphur solution at the rate of one gallon of the stock solution to fifty gallons of water with the nicotine sulphate 40% solution at the rate of one gallon to nine hundred gallons in the diluted lime sulphur solution, this combination proved an excellent spray in killing the red spiders, thrips, and leaf hoppers. The lime sulphur solution in this combination proved effective over as long a time as did the lime sulphur alone against the red spiders on the trees. Examination of the check plot showed the red spiders, thrips and leaf hoppers alive.

## Comparative Cost of Spraying and Dusting

During the time the comparative experiments were made a few figures were taken on the cost of the different dusting and spraying materials employed, and the time required to dust and spray 100 average avocado trees nine years of age.

Comparative Cost of Spraying and Dusting

| Materials | Average amt. used per tree | Price per pound or gallon | Price per tree | Time required to apply to 100 trees | Cost labor 2 men at \$6.00 per day | Cost materials and labor per tree |
|---|---|---|---|---|---|---|
| 1 Sulphur Dust | 1.33 lbs. | \$.0375 | \$.05 | 50 minutes | \$.63 | \$.0563 |
| 2 Sulphur Dust + Nicotine Sulphate | 1.33 lbs. | .15 | .18 | 55 minutes | .69 | .1869 |
| 3 Lime Sulphur Sol. (1–50) | 4.16 gals. | .005 | .02 | 2 hrs. 40 mins. | 2.00 | .04 |
| 4 Lime Sulphur Sol. (1–50) + Nicotine Sulphate (1–900) | 4.16 gals. | .02 | .08 | 2 hrs. 50 mins. | 2.13 | .1013 |

## Conclusions

1. The dusting method with dry sulphur was found to be equally as effective in controlling red spiders on avocado trees over as long a period of time as the spraying method with liquid lime sulphur solution.
2. The experiments proved that it is not necessary that the foliage of the avocado be wet with dew in order that the dry dusting sulphur be effective.
3. Sulphur in any of the combinations used did not control leaf thrips or leaf hoppers, and nicotine sulphate 40% solution when used alone or combined with either lime sulphur solution or dry dusting sulphur will destroy them.

4. Dry dusting sulphur when charged with nicotine sulphate 40% in the form of Black Leaf 40 and applied to avocado foliage was readily removed by succeeding heavy dews and light rains after application. The incorporation of liquid nicotine sulphate 40% caused an aggregation of the sulphur particles and a wettable sulphur.
5. Liquid lime sulphur solution when combined with nicotine sulphate 40% solution proved to be the most satisfactory combination used in combatting the red spiders, leaf thrips and leaf hoppers and remained effective against the red spiders over as long a period as did the lime sulphur solution applied alone.
6. Where a grower has a medium sized grove of avocados, which is usually the case up to the present time, and where a number of insects occur, spraying would be the more effective and cheaper method considering the price of sulphur and nicotine sulphate in the dust form as compared with the same in the liquid form.

## CONTROL OF TWO SCALE INSECTS OF THE MANGO[1]

By G. F. Moznette, *U. S. Bureau oj Entomology, Miami, Florida*

There are a number of scale insects which attack the mango in Florida, but two found to be the most injurious up to the present time and more generally distributed are the Tessellated Scale, *Eucalymnatus tessellatus* Sign. and the Mango Shield Scale, *Coccus acuminatus* Sign. These two scale insects are readily recognized in the field by the difference in shape and color. The Tessellated Scale is oval in shape, but broadly rounded posteriorly. It is of a dark brown in color, with a decidedly mosaic appearance on the upper surface. The Mango Shield Scale is yellowish green, and in shape it is deltoid, bluntly pointed in front and broadly rounded posteriorly. It is very thin and flat and irregularly marked with black.

Both of these scale insects infest the lower surface of the foliage, usually clustered along both sides of the midribs. When very numerous they may also be found along the lateral veins and the interstices. The scales reproduce continuously throughout the year, the generations overlapping considerably so that at any time one may find the scales in almost any stage of development. During the spring months the scales move from the older leaves onto the new growth of foliage. Usually these are the crawlers, but even the older scales often leave their feeding grounds and wander to the new growth.

[1]Published by permission of the Secretary of Agriculture.

The two scales are quite widely distributed, being found on both the east and west coasts of southern Florida. In Florida the Mango Shield Scale has been found on themango, roseapple, custard apple, sapodilla and *Allamanda*. It is also found in Grenada, Barbados, Dominica, Antigua, Trinidad, Jamaica, and British Guiana where it infests in addition to the host plants mentioned in Florida the breadfruit, *Jasminum*, *Ixora*, star plum, star apple and the nutmeg. The Tessellated Scale has been found to infest the mango, cocoanut and roseapple in Florida. In the West Indies it also infests *Caryota urens* and many other palms.

Both of these scale insects produce an abundance of honeydew. The sooty mold fungus develops in this honeydew deposit, giving the mango tree in the course of time a decidedly blackened appearance. The sooty mold often collects on the fruit as well as the foliage, giving the fruit a blackened and unsightly appearance. The writer has observed several groves where the sooty mold was so numerous that even the branches and trunks of the trees were blackened by it.

## Results Obtained with Insecticides

In testing out the following insecticides, badly infested trees were selected averaging from twelve to fourteen years of age with an average heighth of from twenty-five to thirty-five feet. In each case the spray was directed toward the lower surface of the foliage, using a spray gun with a pressure of from 225 to 250 pounds.

## Lime Sulphur Solution

In applying this insecticide to the mango at a strength of one gallon of lime sulphur solution to forty gallons of water in December while the trees were dormant and again in March at a strength of one gallon of lime sulphur solution to fifty gallons of water, it was found, that it did not effectively destroy the scales. The spray killed about 50% of the scales present on the trees, and did not remove the sooty mold present. Due to the tenderness of the mango foliage it was found that the strength of the spray could not be increased.

## Caustic Potash Fish Oil Soap

This insecticide was applied to the mango at the same time and interval as the above spray at a strength of twenty pounds of caustic potash fish oil soap to one hundred and twenty-five gallons of water. The same strength was used during both applications. The results

showed that about 80% of the scales were killed. The soap did not cleanse the trees of the sooty mold, and slight spray injury was noticed after each spraying, especially on the sunny side of the trees.

## Miscible Oil

The miscible oils, of which there are a number on the market, when used at a strength of one gallon to seventy gallons of water during December and repeating with a spraying at a strength of one gallon of miscible oil to eighty gallons of water during March killed approximately 80% of the infestation on the trees sprayed. The miscible oils, however, vary considerably in composition; at times they contain harmful ingredients which may cause foliage injury. The miscible oils did not seem to spread as effectively as the oil emulsions described below which perhaps accounts for the greater percentage of kill where the oil emulsions were used.

## Paraffine Oil Emulsion

A number of paraffine oil emulsions as are used against citrus insects were used. They were applied at the rate of one gallon of the stock solution to seventy gallons of water during December and repeating with another spraying during March, using a strength of one gallon of the stock solution to eighty gallons of water. Results showed that from 90% to 95% of the scales were killed where thorough applications were made.

There are a number of oil emulsions on the market, some of which when combined with the waters used for spraying purposes in southern Florida work very satisfactorily. The waters generally used for spraying purposes in southern Florida come from deep wells in limestone formation and are termed "hard" while those which come from surface wells are as a rule somewhat brackish. There are, however, certain oil emulsions, which when mixed with these waters prove unsatisfactory, because the various salts present in the waters tend to break up the emulsions, causing oil to be set free. This free oil is detrimental to mango foliage and will cause severe foliage injury. If an oil emulsion, which does not perfectly mix with these waters, is used, considerable inconvenience is experienced by the gradual rising of free oil to the top of the tank. This finally becomes more or less gummy, and the working parts of the pump and machine are so coated with it as to hinder spraying operations. In southern Florida, when oil emulsions are used on the mango, it is advisable to test thoroughly to see that no separation occurs, if separation

occurs the water should be first softened by means of caustic potash fish oil soap. This soap has been found to be satisfactory for this purpose by adding four or five pounds to each 125 gallon tank of hard water. There are, however, a number of oil emulsions which contain the proper stabilizers, incorporated in their manufacture, which prevent oil from separating when combined with "hard" waters, thus doing away with the expense of initially softening the water.

## Recommendations

Barring some of the difficulties which may be experienced with the use of paraffine oil emulsions, they have proven the most satisfactory and efficient. The trees are cleansed thoroughly of sooty mold through their use. The writer has found that a paraffine oil emulsion applied in December at a strength of one gallon of stock solution to seventy gallons of water followed by another in March at a strength of one gallon of stock solution to eighty gallons of water, gave good results toward controlling the scales on the mango. A great deal depends upon the thoroughness with which the sprays are applied.

# ARIZONA WILD COTTON OR THURBERIA AND ITS INSECT ENEMIES IN RELATION TO THE COTTON INDUSTRY OF THE SOUTHWEST

By A. W. Morrill, Ph. D., *Consulting Entomologist, Los Angeles, Cal.*

The recent appearance of the Arizona wild cotton or Thurberia boll weevil[1] in several cultivated cotton fields near Tucson, Arizona and the uncertainties in regard to the extent of the infestation, also the uncertainties in regard to the probable infestation of cultivated cotton in the Southwest by the Thurberia bollworm[2] constitute a serious menace to the cotton industry of the Southwest, and at the same time serve as an object lesson in the handling of complicated insect problems. A review of the facts in regard to the situation referred to will place on record a statement of entomological principles involved in the wild cotton problem and tend to prevent further meddling by politicians with matters involving grave dangers to agricultural industries and which properly belong to the field of economic entomology.

That the Thurberia weevil is evidently better adapted to the climatic conditions of the arid and semi-arid southwest and consequently a more serious menace to cultivated cotton in that region than the eastern

[1] *Anthonomus grandis thurberiae* Pierce [2] *Thurberiphaga catalina* Dyar

variety of the boll weevil[1] has been repeatedly pointed out in various publications following the early investigations of the problem, principally by Dr. W. D. Pierce and the writer in 1913[2] and Mr. B. R. Coad in 1914. The possibility that the Thurberia weevil might not be able to adapt itself to lower elevations than its known habitat in the mountains of Southern Arizona provided a basis for a certain amount of optimism but the seemingly well grounded hope that the insect might be restricted in its future distribution by the factor of elevation was dissipated in 1916 by the discovery of the Thurberia weevil at sea level in Sonora, Mexico, by Mr. E. A. McGregor. A maximum longevity record of 626 days for the Thurberia weevil brought to my attention by Dr. Pierce in correspondence has further emphasized the peculiar status of the insect as a potential pest of cultivated cotton. Fortunately, under natural conditions, the relation of the food supply to the weevil in the native habitat of the latter has been such that as long as the "status quo" of the insect and its native food plant was undisturbed, the danger of infestation of cultivated cotton in the valleys was practically limited to water transportation by means of floods from the mountains. The ill advised disturbance of this generally satisfactory relation by an eradication campaign directed against the plant rather than its insect enemies, even followed as it was by a season of unusually light rainfall and absence of floods reaching into the valleys, made infestation of cultivated cotton by flight of the insects, practically inevitable. The discovery of the weevil infestation in cotton fields in October 1920, bore out a prediction made with the utmost confidence by the writer after an investigation of the situation several months earlier.

While the Thurberia boll weevil has been generally considered the most noteworthy of the pests of the Thurberia plant, the potential importance of the Thurberia bollworm[3] has never been questioned and it is obvious that the existence of the latter in the same localities as the weevil, introduces a complicated problem which must be taken into consideration in any intelligently planned attempt to eradicate the weevil and its host plant in any area. It is of interest as a side light on the situation that, according to a statement made to the writer by Dr. C. T. Vorhies of the University of Arizona, the Thurberia bollworm was not discussed or considered in connection with the planning of the eradication campaign which was done at a conference he attended early in October, 1919.

The rapid development of the cotton industry in the Southwest having made desirable a reconsideration of the wild cotton problem

[1]*Anthonomus grandis* Boh.
[2]Pierce and Morrill. Proc. Ent. Soc. Wash. vol xvi, pp 17–19, 1914.
[3]Morrill, Fifth Annual Rept. Ariz Comm. Agr. and Hort. p 47, 1914.
Morrill, Jour Econ. Ent. vol. x p 312, 1917

in Arizona, a survey of the distribution of the plant was made in certain districts adjoining cultivated lands near Tucson in the summer of 1919. It was expected that this survey, when completed, would serve in connection with entomological surveys as a basis for determining what, if any, protective measures might be practicable and advisable. Ignoring very elementary factors in the insect problems as set forth in the several publications on the subject, the Arizona officials planned and began in October 1919 a Thurberia eradication campaign near Tucson. Eradication work was referred to as follows in an official statement issued in November, 1919: "This office is actively engaged in the eradication of the Thurberia. . .in the washes of the Santa Catalina mountains. . . . The problem is well defined, the plant in the lower altitudes grows only in the washes and canyons. A competent man to superintend the work, a number of Mexican laborers, picks and a bar constitute the necessary equipment. The plants are being pulled or dug out and root and top burned." In a statement made public on May 11, 1900 the eradication work accomplished and plans for further activities were described as follows:

"Last summer a survey of the wild cotton plant and its eradication in the washes of the south and west slopes of the Santa Catalina Mountains and the west slopes of the Santa Rita Mountains was undertaken under the direction of the State Entomologist.

"With a view to safeguarding the cotton industry of the districts adjacent to where Thurberia grows, the Commission has decided to continue the work of eradicating the wild cotton plant and as an additional safeguard, to establish a zone within which no cotton may be planted during the coming season."

For the information of business interests related to the cotton industry, the writer, early in 1920 began an investigation of the wild cotton situation and discovered that a condition very dangerous to the cotton industry of the Southwest had been created. In order to reduce the problem to its simplest terms and show the unprejudiced views of professional entomologists concerning the action of the Arizona authorities, a questionnaire was prepared and sent to several members of the Association of Economic Entomologists. The conditions stated in the questionnaire were carefully compared with the literature on the wild cotton by two other members of the Association. The answers to the questionnaire were all in agreement and written statements were secured certifying that the conditions as stated, agreed with the literature

on the subject. The following is a copy of the questionnaire[1] with the most terse representative answers:

"A valuable agricultural crop A is grown in valleys near mountain ranges where a closely related plant B is widely scattered with a natural range extending down to within less than five miles of cultivated land in some cases. Plant B is known to be generally infested with two destructive insect pests, a weevil X and a moth larva Y which are known to attack the cultivated plant, A, whenever available, exhibiting no noticeable preference between the two food plants. Investigations of these two insects by state and U. S. Government entomologists have lead to warnings concerning the danger to the cultivated crop A.

"Plant B grows scatteringly over thousands of square miles of drainage country and investigations have led to the conclusion that infested parts of the plant are frequently washed down by water flow from the higher altiudes. In some cases, the water even when in considerable quantities disappears in the sands in the lower ends of the canyons leaving debris which is supposed to frequently include parts of plant B infested with X. In such cases it is logical to suppose that the specimens of the weevil X thus transported are attracted by plants B growing in the vicinity and the cultivated crop A is thus under natural conditions protected against the danger of infestation by flights which would be forced if none of the wild food plants B were naturally growing in the vicinity near where the infested plant material is deposited by the water.

"Plant B naturally produces a great abundance of food for all insects which attack it and under normal conditions it is evident that migrations of such insects never result from a shortage of food supply. This abundance of food has doubtless in the past acted as a protection to crop A.

"The adult of insect Y is unknown but the larva is robust and apparently is that of an active noctuid moth which has been supposed to be capable of flying a considerable distance. Two entomologists, specialists on insects affecting crop A who conducted the principal investigation of insects affecting plant B reported in an article published in a scientific journal that insect Y was even more destructive to its food plant than insect X, the inference being that Y was even more to be feared as a potential enemy of crop A than was insect X.

[1]Questions 5 and 7 are omitted in order to save space.

"The active period for the adults of insects X extends from July 1 to November 15th[1] varying with the elevation and climatic conditions. The adults hibernate inside the ripened and dried fruit of plant B. The adults of insects Y are active during July and August, the worms going into the ground in September and October where they transform to pupae, in which condition the insects spend the winter. The larvae reach full size and go into the ground between September 1st and October 15th according to present knowledge of the insect's life history.

"So far as known neither insect X or insect Y has any other food plants than A and B. Crop A is grown in several irrigated valleys of limited acreage separated by stretches of desert of from 50 to 100 miles in each case. The total value of crop A grown within 250 miles of this locality is above fifty million dollars. The plant B is found in the close proximity to only one of these valleys.

"With the foregoing conditions in mind will you please give your opinion in regard to the following points:

1st. If there were no other insect or insects than weevil X to be considered, during what period of the year could the destruction of food plant B by "chopping out" and burning the plant be carried out over the whole or a part of the insects' range without danger of forcing a migration of adults to crop A?"

REPRESENTATIVE ANSWER: "November 15 to July 1"

2. If there were no other insect than Y to be considered, during what season, if any, could the destruction of food plant B be carried out over a whole or a part of its range without danger of forcing a migration of the insects to crop A?"

REPRESENTATIVE ANSWER: "Destruction to be of value should be conducted during July and August, leaving trap plants which should be sprayed or the larvae feeding on them killed. Destruction of the plants between September and following July would probably force migration of moths coming from hibernation in soil."

3. Assuming that the worms and pupae of Y in the ground near the plants thus destroyed were left undisturbed and assuming that no attempt was made to collect the adult weevil X from the plants before they were chopped out by common laborers, what would be expected as a natural consequence if the wild food plants, B, were destroyed during October and November?"[2]

[1]The first killing frost may be considered as definitely ending adult weevil activity. The average date of this at Tucson is November 22.

[2]The eradication campaign was started on or about October 13, 1919. Fortunately, the first killing frost occurred on November 9.

REPRESENTATIVE ANSWER: "Would destroy few of X and none of Y and would probably force search of food within range of flight of insects X and Y."

4. Would it be logical and advisable to destroy the plants B growing within five or six miles of the mouths of the canyons (where infested debris containing weevils X is supposed in many cases to be deposited by water) before the plants B are destroyed higher up on the water shed?"

REPRESENTATIVE ANSWER: "No. Should be left as trap and insects destroved."

6. Would you characterize the destruction of plants B at the lower ends of the canyons and adjoining washes during October and November, with no attempt to collect the adults of weevil X or destroy the larvae and pupae of moth Y in cells in the ground near the food plants or to destroy the plants at higher elevations as (*a*) a logical and highly commendable action likely to prevent infestation of crop A. (*b*) as a matter of little consequence from any standpoint or as (*c*) a colossal blunder diametrically opposed to good entomological practice and seriously threatening to agricultural interests?"

REPRESENTATIVE ANSWER: "As (c)."

No one, prejudiced or unprejudiced, has found any detail of the conditions stated in the questionnaire which does not correspond in all essential points with the several publications relating to the subject. However, it should be pointed out that in the second paragraph it would have been more in accord with the facts to have stated that in "most" rather than "some" cases, the water even when in considerable quantities disappears in the sands in or near the lower ends of the canyons.

Wide experience with the cotton boll weevil has demonstrated that narrow non-cotton zones, such as the Arizona officials have attempted to maintain, are worse than futile in stopping the progress of the weevil. In general, the weevil will cross a five or ten mile non-cotton zone faster than it would cross the same area planted entirely in cotton. The weevil and food plant relationships having been disturbed during a critical period and at a place where most easily thrown completely out of adjustment, the outlawed cotton plantings which became infested evidently served a most valuable purpose as trap crops. Unfortunately there were too great intervals between these outlaw fields. Under the circumstances which existed the more cotton grown in the prohibited

area the better would be the protection of the vastly more important cotton sections within range of flight of the two insects here discussed. However, the direct results of migrations of weevils forced in the fall of 1919 have not yet been ascertained since the inspections in the field have covered only an insignificant fraction of the total number of cotton stalks. In Pima county alone there were approximately forty million stalks and the 188 man-days spent in field inspections could not have been equivalent to the thorough inspection of a hundred thousand of these. If the assumption is correct that no infestations exist in Arizona out-side of the fields where the weevil was actually found, the protective value of the outlaw cotton was greater even than I had supposed.

Necessary space limitations make it impossible to consider here the proper methods of dealing with the wild cotton problem in Arizona. The writer plans to discuss this in other papers on the subject. The more immediate need is for an understanding in political circles of how not to deal with the problem and this paper will doubtless serve a useful purpose in this connection.

## OBSERVATIONS ON NATURAL ENEMIES OF THE FALL CANKER-WORM (*ALSOPHILA POMETARIA* PECK) IN FORESTS OF SOUTHERN ALLEGHANY MOUNTAINS, IN 1920

By F. Sherman, *Entomologist, State Dept. Agriculture, Raleigh, N. C.*

### The Condition

In the years 1917, 1918, and 1919 there were repeated reports of injury by Fall Canker-worm to certain limited areas of wild mountain forests in western North Carolina. Approximately twenty such areas, in nine different counties, were reported,—the areas varying in extent from 10 to 200 acres or more. The injury occurs chiefly in June. Land owners were not familiar with this insect, and were apprehensive lest it should continue to increase and spread until the forests were damaged beyond recovery.

As most of the areas are without roads, with steep slopes and often with much miscellaneous undergrowth, such methods as banding and poisoning were out of the question. It was therefore decided to make a study of the natural enemies during June of 1920. The area selected was on the summit of Hump-back Mountain in Avery County, N. C., 4,170 feet elevation, giving conditions suggestive of the more northern states—Transition Life-Zone, bordering on the Canadian. The observation covered the period from May 27 to June 24, 1920.

## Birds

A total of 53 species of birds were recorded in or near the infested area,—of these the following highly insectivorous Passerine birds were observed so commonly in the area that they could fairly be presumed to be of material help:—

1. Mountain Vireo.
2. Red-eye Vireo.
3. Black and White Warbler.
4. Parula Warbler.
5. Black-throated Blue Warbler.
6. Chestnut-sided Warbler.
7. Black-throated Green Warbler.
8. Ovenbird.
9. Yellow-breasted Chat
10. White-breasted Nuthatch.
11. Tufted Tit.
12. Chickadee (prob. southern form).
13. Wood Thrush.
14. Veery.
15. Robin.

The variety and number of insectivorous birds appeared to increase in the worm area, but the concentration was not so pronounced as one might expect,—evidently there was much insect food outside the area. The above 15 are selected from the total of 53 species. Among the others were many which probably do feed on canker-worms. (The list included Pileated Woodpecker and Brown Creeper, among others).

## Predaceous Insects

*Calosoma frigidum* Kirby. (Coleop. Carab.). Despite much collecting in mountains we had not before taken this species in the state, yet it was found to be common in the worm area, was not found outside of the area, and did become increasingly conspicuous. They were often seen climbing among the twigs and foliage of infested trees, not only on cloudy days, but on clear days as well,—this was especially so when the worms became less numerous by reason of maturity. This species easily takes first rank among the insect predators observed, and in aggregate helpfulness was second only (if second) to the egg-parasite mentioned later. Its general distribution is northerly.

*Calosoma scrutator* Say. Found only the remains of one dead specimen.

*Podisus modestus* Dall. (Hemip. Pentatom.). This northerly bug takes second rank among the predators,—it was common, or rather, abundant,—and specimens were often seen with worms impaled on their beaks. It is widely distributed through our mountains.

*Lygus sp.* (Hemip. Capsid.). One or more species of these were abundant, and several were seen with worms impaled on their beaks.

*Ants*, (2 sizes, black). Twice seen dragging worms.

*Panorpa sp.* (Neurop.). Several species were abundant, one was seen devouring a worm.

## Parasitic Insects

*Telemonus sp.* (Hymenop. det. A. B. Gahan). Early in this study a number of egg-masses of Fall Canker-worms were collected from which the larvae had hatched. It was observed that perhaps 25% to 40% of the eggs had not yielded larvae. From these this parasite was easily reared. This was apparently the most useful parasite. It is uncertain whether this or *C. frigidum*, should be given first rank among the natural enemies, in total good accomplished.

*Euplectrus sp.* (Hymenop. det. A. B. Gahan). Several Canker-worms were found with very small external parasitic larvae attached. From one of these this species was reared.

*Sarcophaga cimbicis*, or, *latisterna*, (Dip. Tachin.). One specimen was reared from Canker-worm. The specimen is female, and *may* be either of the above species. (det. J. M. Aldrich).

## Collected Species

During the study six species of Tachina-flies were collected in the worm area,—of these *Masicera eufitchiae* Twnd. was common. Also eight species of Ichneumonidae were taken among which were four species of *Amblyteles*, which may be parasitic to canker-worm, — the others were larger species which probably do not attack it.

## Fungous and Bacterial Disease

It had been expected that these would be in much evidence by this, the fourth successive year of attack. This did not prove to be the case, although warm and damp weather was not lacking. Only an occasional worm was found which seemed to have perished from disease, and there was no hint of an epidemic among them. This condition may yet develop.

* * * * * *

While the canker-worms were present in countless numbers, yet residents testified (and evidences were observed) that the defoliation was not so complete in 1920 as it had been in 1917, 1918, and 1919.

It is believed that this was due largely to an increase in the efficiency of the natural enemies, especially *Calosoma frigidum*, *Telemonus* sp., and *Podisus modestus*,—(doubtless others helped), and the small birds. This gives basis for the hope that these may continue to increase, causing a further subsidence of the outbreaks, until the canker-worm may again become inconspicuous. An outbreak of disease among the worms would hasten this result.

The study was interesting and enlightening, and led to an increased appreciation of the unseen good which natural factors accomplish, especially in wild areas like the one under study, where artificial control seems hopeless. The area also proved to be a good one for insect collecting, especially in the family Cerambycidae.

## THE EUROPEAN CORN BORER AND THE SUGAR CANE MOTH BORER: A COMPARISON[1]

By T. E. Holloway, *Entomologist, Southern Field Crop Insect Investigations, U. S. Bureau of Entomology*

Two prominent State Entomologists have recently requested data of the writer concerning the sugar cane moth borer and the similarity in its life history and damage to the European corn borer. After reading the papers and the discussions on the new pest in the Journal of Economic Entomology, the writer decided that possibly he should place the information on the two species in such form as to be readily available for comparison. While the climate of Louisiana is very different from the portions of New England and New York which have been infested by the European corn borer, yet information on the sugar cane moth borer may indicate in some degree what may be expected of the European insect.

### Systematic Positions

Both insects are of course Lepidopterons of the family Pyralidae. The European corn borer, *Pyrausta nubilalis*, is in the subfamily Pyraustinae, while the sugar cane moth borer, *Diatraea saccharalis crambidoides*, is in the subfamily Crambinae.

### Damage to Corn and Sugar Cane

The corn crop as planted in Louisiana is largely out of the way before the maximum development of the sugar cane moth borer is reached. Corn is usually planted about March, and is mature by mid-summer. While holes and tunnels may be found in the stalks, and while any injury to the stalk must have an effect on the ear, still the damage is usually so slight as never to have been estimated. Doubtless the weight of a number of ears from infested plants would be found to be somewhat less than an equal number from uninfested plants. As for the ears themselves, they are rarely damaged by the sugar cane moth borer. A larva is sometimes found to have entered an ear from the stalk, but this damage is negligible.

[1]Published by permission of the Chief of the Bureau of Entomology. Read at a meeting of the Louisiana Entomological Society, June 3, 1921.

All this refers to corn as ordinarily grown. Late corn is often so seriously injured as to be worthless.

As to sugar cane, this crop grows till fall, and beginning about September the damage increases rapidly. It is estimated that the average loss is about 16% of the crop, though it is sometimes as high as 33%.

There is also an injury to young corn and cane plants, the larvae entering the stalks at the surface of the ground or a little below and killing the plants.

From the literature, it would seem that the European corn borer may do much more damage. Caffrey (1) writes: "The larvae or borers of the European corn borer tunnel through all parts of the corn plant except the fibrous roots. They even feed within the midrib and upon the surface of the leaf blades. They cause their most serious damage, however, by their work in the stalks and the ears, which they partially or totally destroy. Generally, they enter the stalk at its upper end near the base of the tassel, and at first tunnel upward. This damage so weakens the tassel stalk that it breaks over before the tassel matures, resulting in loss of pollen and the lack of normal grain formation on the ears. . . . Field counts in badly infested areas have shown as many as 60% of the tassels broken over in this manner."

More recently, Felt (5) writes: "Generally speaking a 30 percent. stalk infestation is necessary to produce marked commercial injury though in some fields with a 10 percent. stalk infestation as high as five percent. of the ears of sweet corn were affected and judging from conditions in other single brooded areas, a 90 percent. stalk infestation of field corn by no means implies the destruction of the entire crop, though it does involve serious damage. There has been in New York State no very serious losses due to the actual work of the European Corn Borer though the 30 percent. to 40 percent. stalk infestation in the more seriously infested areas suggests a probability of increased injury and possibly an approximation to the great damage caused in certain Canadian areas."

## Food Plants Other than Corn

The sugar cane species is unlike the European corn borer in that it does not attack various weeds, though it does breed in Johnson grass and other large grasses. On a sugar plantation both corn and sugar cane are grown. The stalks of planted cane undoubtedly supply many moths for the infestation of both corn and sugar cane, as it has been found that the moths can emerge from one half inch of packed soil. In the case of both insects, moths come from a source other than corn.

## Progress of Infestation

In a discussion at the meeting of the Association of Economic Entomologists at St. Louis on December 31st, 1920, it was mentioned that the infestation by the European corn borer was extremely low in places.

Judging from the related insect, however, the opinion of the writer is that this means very little. If the infestation is very low now it may be some years before there is an important loss, but the loss is probably to be expected.

Some years ago the writer happened to make examinations on a plantation which had previously been under water for a number of weeks, all that section of the country having been overflowed. The infestation of sugar cane in the fall was 4% of the stalks, which would mean that at the time the corn was gathered there was practically not a trace of borers in the fields. The writer made a point of visiting this plantation the following year, and he found that the infestation of sugar cane had risen to 6%. One year later it had climbed to 68%, and the following year it was 87%. With an 87% infestation in sugar cane, late corn would not have been successful.

The writer cannot predict similar activities on the part of the European corn borer, but it evidently develops earlier in the season than the sugar cane moth borer, and even more damage might reasonably be expected of it. It should be pointed out that the sugar cane species is really a tropical insect which was brought to Louisiana in shipments of seed cane, and that it develops much more slowly than do insects which are native to Louisiana. The European corn borer, on the other hand, comes from a region where the climate more resembles that of the northern states, and it apparently reaches a heavy infestation much earlier in the year.

## Habits of Adults

Caffrey (1) states: "Soon after emergence the moths mate and begin to deposit eggs. They remain quiet during the day, hiding in patches of grassland or underneath the leaves of plants. At night they fly from plant to plant, depositing their eggs in flat, irregular-shaped masses of from 5 to 50 eggs each, on the underside of the leaf. Each egg overlaps the adjoining eggs in the manner of shingles."

This was written about the European corn borer, but it almost perfectly describes the habits of the sugar cane moth borer.

## Number of Eggs

The average number of eggs deposited by the sugar cane moth borer is about 200, while according to Caffrey (1) the average for the European corn borer is 550 for the first generation and 350 for the second. In both species the sexes are about evenly divided.

## Generations

The sugar cane moth borer has two to five generations in Louisiana, while the European corn borer has one in New York and two in New England (1, 2).

## Feeding Habits

Caffrey (1) mentions the habit of adults of the European corn borer of depositing eggs on dead and dried corn stalks. This never occurs with the sugar cane moth borer, and if it did occur that insect would probably be far more injurious than it is, as there would be many borers carried over the winter in old corn stalks. Careful examinations in Louisiana have failed to prove that there is any hibernation whatever in old corn stalks. As mentioned above, there is little injury to the ear from the sugar cane moth borer, while this is one of the principal forms of injury by the European species. Otherwise, the feeding habits of the two insects are similar, both tunneling in the stalks of their host plants.

## Extension of Territory

The sugar cane moth borer has for years remained restricted to about the same territory. It is distributed mainly through shipments of infested seed cane. Apparently, the European corn borer extends its territory very rapidly, according to Felt (2), who points out that the larvae were probably carried in shipments of green corn to summer hotels south of Boston. The shipments of sugar cane outside the area infested by the sugar cane moth borer are negligible, though there is doubtless some shipment of ears of corn for cooking.

## Hibernation

Both borers pass the winter in the larval stage in their tunnels, though the sugar cane moth borer is then limited to sugar cane and grasses while the European corn borer hibernates in the cobs and stalks of corn (1). The sugar cane moth borer extends its larval period to as much as 276 days for hibernation. The European corn borer may live for over a year in the larval stage (1).

## Natural Enemies

Marlatt (3) brings out the fact that the European corn borer is well parasitized by *Trichogramma minutum*. This efficient parasite attacks the eggs of the sugar cane moth borer, but develops so late in the season that it is not quite an effectual means of control. Nearly 100% of the eggs are parasitized in the late fall, however, which must greatly reduce the number of hibernating borers. The parasite has been rendered more effective by avoiding the burning of the leaves of sugar cane left on the fields after the cane is cut (4). A tachinid parasite is now being introduced from Cuba.

## Many Sugar Cane Moth Borers Destroyed in the Manufacture of Sugar

It should be pointed out that every fall the sugar cane in Louisiana, some 300,000 acres, is cut and most of it (except what is used for planting) is ground in the process of making sugar. This kills all the larvae in the stalks, and forms what one might call a kind of "automatic" control. Of course there is no such factor in the control of the European corn borer.

## Effect of Arsenical Poisons

As with the European corn borer (1), so with the sugar cane moth borer (4) arsenical poisons are not efficient.

## Possibility of Injury from the European Corn Borer

Judging from the comparisons given above, it would seem that the European corn borer will often cause serious damage in the North, while if it should invade the Southern States it may be even more injurious.

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# CONTROLLING THE ARMY-WORM IN SOUTHEAST MISSOURI

By Vernon King and Geo. W. Barber, *Cereal & Forage Division, U. S. Bureau of Entomology*

The late Lieut. Vernon King was for upwards of three years a member of the staff of the Cereal and Forage Insects Investigations of the U. S. Bureau of Entomology. For considerably over a year he was in charge of a laboratory located in Charleston, Missouri, and here, with the assistance of the junior author, he carried on investigations of many insects injurious to cereal and forage crops.

Because of the hurried departure of Mr. King in the Fall of 1914 to enlist under the colors of England, his native country, and due to the more or less incomplete nature of his experiments, no contribution from his pen to the literature of American Economic Entomology has been published under his name.

To fill this want, and in justice to the memory of Mr. King, who met death on the field of battle, the junior author has gone over his notes and photographs and presents the following short article as representing a small portion of Mr. King's work. The method of control which is here described is entirely the system developed by Mr. King and the figures are from his photographs.

The region commonly referred to as Southeast Missouri embraces a considerable area of reclaimed, cypress swampland about seventy miles wide and nearly one hundred miles long in Missouri, extending into Arkansas and embracing nearly the entire eastern half of that state. Here, for ages, the Mississippi River has yearly overflowed its banks, adding each year a thin layer of soil. The section is now being fast reclaimed by extensive systems of drainage canals and protected by levees from the overflow of the river. The climate is warm and humid with a large annual precipitation and this region already is beginning to show its importance as one of the principal agricultural sections of the state. Here, also, thanks to the comparatively inexhaustible nature of the rich, black soil, all vegetation takes on a very rank growth and injurious insects become more and more important.

Among the more important insects often injurious to the agriculture in this section, the army-worm, *Heliophila unipuncta*, is almost annually of importance, frequently occuring in large numbers and destroying considerable areas of crops. Often the migration of the larvae is from the maturing wheat to adjoining or nearby fields of young corn, when, unless prompt steps are taken for the control of the insect, the corn is entirely destroyed.

1

2

1. Using the larger log, showing method of "riding."
2. The plow and barrel at work, showing the different appearance of the furrows (Photos by Vernon King).

During the Spring of 1914, the army-worm was very numerous; observed first about May 13th, by the 20th to 23d they began migrating from the wheat into the corn fields, the principal migration occurring at about 2:00 P. M. of the 21st and between 4:00 and 5:00 P. M. of the 23d. So large was the number of larvae issuing from the wheat that they produced a distinct rustle as they moved among the leaves. By May 29th the larvae were entering the soil to pupate and were becoming scarce.

Predatory enemies and parasites were, in 1914, so numerous as to probably destroy from fifty to sixty percent of the larvae.

The bob-o-link (*Dolichonyx oryzivorus*) occurs in such large numbers about the wheat fields where the army-worms are plentiful that the farmers call the species the "Army-worm bird" and believe, evidently with some justification, that their presence always indicates the advent of army-worms.

Calosoma beetles, *C. scrutator*, *C. lugubre*, and *C. calidum* become very numerous indeed during the seasons of great abundance of the army-worm in this region, and were particularly numerous during May of 1914, although by the latter part of June they were scarce and by July were difficult to find.

Toads occur in considerable abundance and undoubtedly destroy large numbers of the larvae, particularly where they congregate in the furrows.

Parasitic flies were, during 1914, very numerous; the principal species being *Winthemia 4-pustulata* and *Frontina aletiae*. Hymenoptera apparently were less abundant although *Apanteles militaris* was quite generally present and was reared in some numbers from the larvae.

Of the various schemes investigated in 1914 to protect the young corn fields from the swarming larvae, the two-furrow plan without post holes appeared most successful on heavy soil. In this system two furrows are plowed along the edge of the corn field adjoining the wheat, or from the direction that the larvae are expected to enter the field. These furrows are about three feet apart and are first made with a one-horse plow, followed with a heavy three-horse plow to throw the earth up towards the side of the corn field, above the level of the ground. The last plow is followed with a log 3′ x 8″ diameter to break up clods in the bottom of the furrow. A second log (Pl. 6, fig. 1) about 16″ in diameter and about two feet long is then drawn through the furrow to smooth the bottom and lower half of the sides of the furrow. Finally a barrel (Pl. 6, fig. 2) dragged through the furrow smooths the sides

still more. At first, it is more or less difficult for the driver to ride astride of the logs and barrel but by balancing himself, by means of two short sticks, one in each hand, the difficulty is soon overcome. The logs and barrel may be used each morning to keep the sides of the furrow pulverized and smooth, in which condition the larvae cannot attain a foothold, and may be used frequently through the period of maximum migration to kill larvae in the ditch.

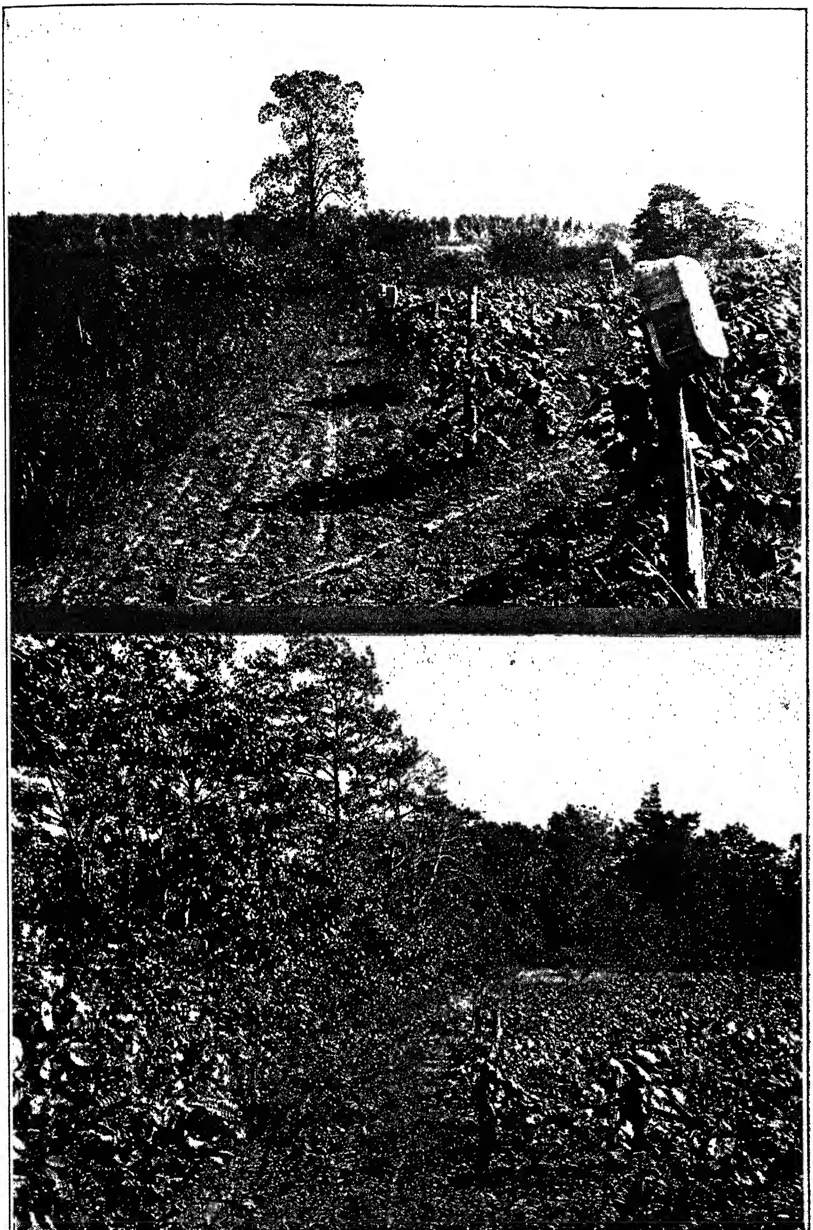
On very light soil, such as is found occasionally in this section, as sandy bars, the ditches with post holes at every fourteen feet serve the purpose, but with post holes the ditches cannot be dragged and the post holes on heavy soils were found to be useless.

## FACTORS DETERMINING LOCAL INFESTATION OF THE GRAPE BERRY MOTH

By J. G. SANDERS and D. M. DELONG, *State Capitol, Harrisburg Pa.*

Throughout the great grape growing areas in the Eastern United States especially, the Grape Berry moth has been rightly considered a very important pest. Many years in the aggregate have been spent by a number of men in attempting to control this pest, and all of the experimental work carried on to date has had as its basis the poisoning of the larvae. Although some attention has been given to cultural methods, practically no thorough study has been made of natural conditions under which the moth survives, and little comparison of areas of infestation with those uninfested has been made. The ecological factors often must be considered in the distribution and survival of a pest.

For the past three years, 1918 to 1920 inclusive, a survey and study has been carried on in the North East, Pa., area of the Erie-Chautauqua grape belt, in which an area of approximately thirty-two square miles was given careful consideration, and approximately three hundred vineyards were examined. Vineyards having all types of topography were visited and inspected during these examinations, and adjoining vegetation combined with the various degrees of attention and cultivation were carefully noted. The determination was made of the extent of infestation and the conditions controlling it. It has been definitely shown that grape berry moth infestations occur in the vineyards in a very spotted and localized manner. As a rule a single field is neither entirely nor uniformly infested, and its condition is not an index of the adjoining fields, unless similar conditions occur.



Grape Berry Moth infested Vineyards.

Upper—Vineyard bordered by weedy and uncultivated area.
Lower—A border of woodland and low shrubs.

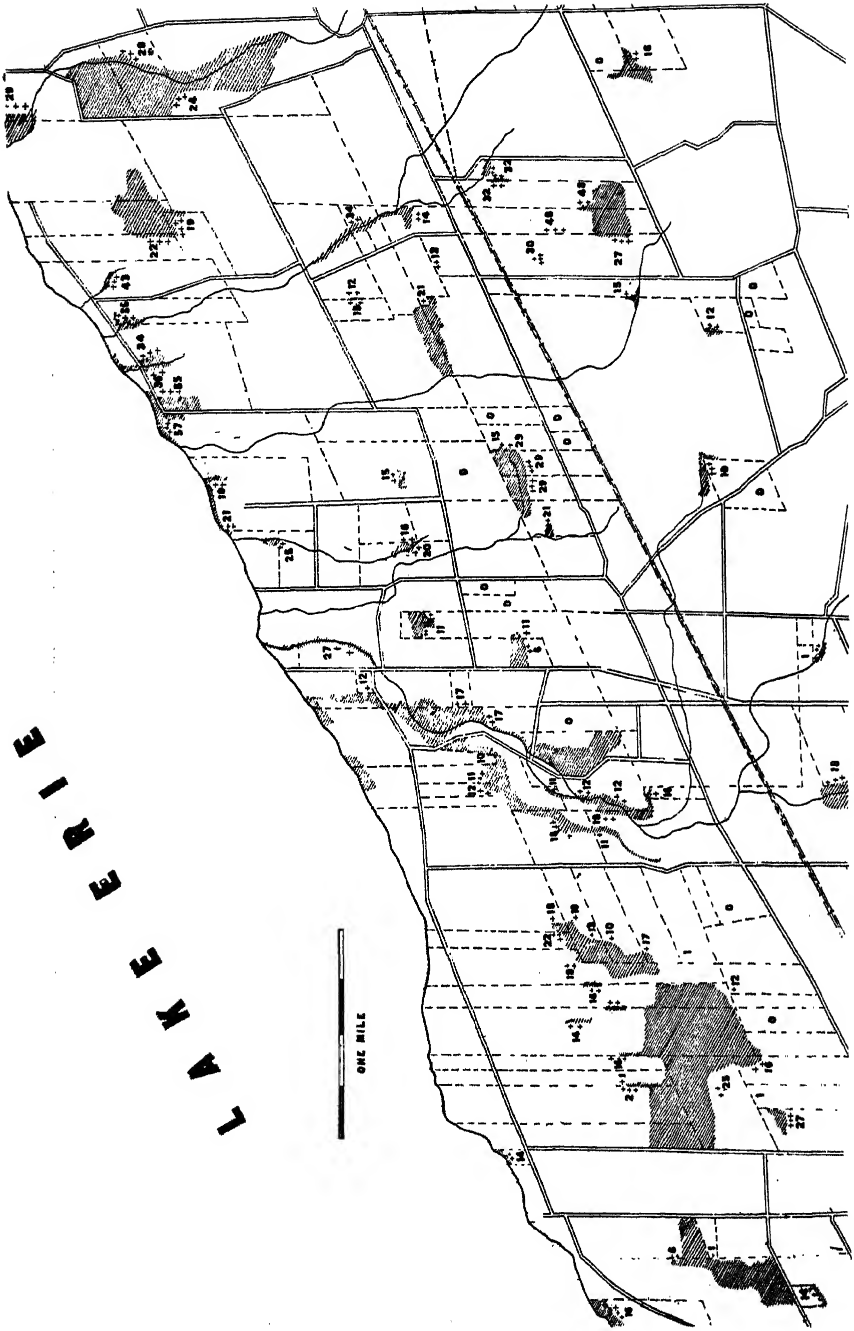



Fig. 10 Diagram of grade region about North East, Pa. Shaded portions show wooded areas and figures indicate percentages of infestation adjoining.

Areas of infestation are due entirely to the existence in the immediate vicinity of conditions which are suitable to the over-wintering of the pupae, which are usually found in dry grape leaves. Conditions favorable to the collection and aggregation of dry leaves—often blown by the wind—are found in weedy headlands, woodlands, uncultivated fields adjoining strips of uncut weeds along the vineyard, or an abrupt depression where snow by drifting can cover the leaves, and thus protect the pupae from freezing. The autumn winds carry the leaves to these grassy and woody areas, where they are held and protected over winter.

These facts have been verified by placing numerous grape berry moth pupae respectively in protected and in exposed areas, with the result that those in the open vineyard areas are killed, apparently by freezing and the varying temperatures.

The amount of infestation of these vineyards ranges from zero to fifty-seven percent as a maximum. Perhaps ten to fifteen rows toward the open vineyard showed a very slight infestation or none whatever.

An examination of vineyards throughout the entire area has shown this condition to be practically uniform, and when this condition is observed year after year it is apparent that the infestation does not continue to spread during consecutive years, but that the pupae are killed each year, except in the protected zone. Since the flight of the moths is quite limited, the same areas are reinfested each year from the same source. These vineyards under consideration are generally well cultivated, and little opportunity exists for vegetation to carry overwintering pupae.

During these observations one vineyard was found containing an almost uniform infestation of approximately forty percent. On further consideration it was discovered that this vineyard had not been cultivated for several years, and conditions for overwintering were ideal throughout the vineyard. Abrupt depressions in contour, or swales, occurring in the midst of a cultivated vineyard will furnish the only infestation found in an area of several acres, and the largest percentages of infestation found are caused by a combination of depressions and stretches of abandoned or uncultivated ground, containing a growth of sumacs, brush, or heavy weeds, or a generally wooded area. After a little practice and study of infested areas, these suspicious portions can usually be picked out at a glance over the entire vineyard before clusters are examined.

The direction of the woodland from the vineyard seems to make very little difference, so long as it adjoins the vineyard closely. Slightly more protection, with resulting heavy infestation, seems to be afforded

by a west or northwest wooded area. Little difference is observed whether the grape rows parallel the wooded or waste land strip, or are perpendicular to these conditions in the area affected by the moth, for the spread seems to be uniformly deep under each condition. By reference tot he accompanying map (Fig. 10) a remarkable variation in percentages of infestation in portions ofthe various vineyards will be noted.

During the summer of 1919 spraying and dusting experiments were carried on in the vineyard which had a heavy infestation, and although results were excellent, they were not reliable, for it has been proven that the heavily infested area coincided with the check plot, the only manner in which the relative merits of spray materials can be determined against this pest is to be certain that the areas treated in both cases are uniformly infested, which is not the case throughout this region, except the one uncultivated field mentioned above.

In conclusion it seems only reasonable to believe that the most effective way to control the grape berry moth is by burning over and clearing waste places and head lands. This was tried out by one grower during the season of 1920, and showed excellent results where a spotted infestation had occurred the previous season. In cases where trees or vegetation are left as protective wind breaks, the general spraying must be continued, but it is shown that in many cases the study of the local conditions will help the grower to combat this pest more easily. Great emphasis should be placed, however, on cultural and clean farming methods in attempts to control the grape berry moth.

## THE EFFECT OF TIME OF SOWING UPON THE CONTROL OF THE WHEAT SHEATH WORM (*HARMOLITA VAGINICOLUM* DOANE)[1]

By T. H. Parks, *Ohio State University*

Observations commenced in 1918 and continued through four seasons, have pointed to time of sowing as an effective control for this injurious wheat insect in Ohio. The annual Wheat Insect Survey has given us data pertaining to both *Harmolita tritici* and this species with respect to date of sowing. Observations upon the development of *H. tritici* have not shown much relation between sowing dates and degree of infestation. In 1918, when observations were commenced with *H. vaginicolum*, it was apparent that time of sowing had a great deal to do with the degree of infestation. During that year in Northeastern Ohio all spring wheat and all late sowed winter wheat were badly infested with this insect, and the yields greatly reduced.

[1]Formerly genus Isosoma. Revised by Phillips and Emery, Proc. U.S. Nat. Mus. 55, pp.440.

The injury was first described by Doane[2] in 1916, who observed serious damage to occur on the dry farms of Utah. The adult insect lays several eggs in the leaf-sheath around the stem above the upper joint. The larvae developing within cells in the sheath, cause a swelling and hardening, which later results in the sheath above this point becoming much enlarged. If the plant is well developed at egg-laying time, the affected straw is short, and usually greatly distorted or bent at the upper joint. If the plants are quite young at the time of oviposition, the head is always stunted, and is often undeveloped or unable to push its way beyond the topmost leaf-sheath. Many straws do not get tall enough to be cut by the reaper. This is especially true of wheat growing in finishing furrows where growth has been retarded, and the straws are more suitable for the work of the insect. An infestation of 20% may mean a loss of one-fifth of the yield. The same infestation of *H. tritici* will probably reduce the yield but little, unless lodging occurs. *H. tritici* infested straws usually mature a satisfactory head.

In Ohio the injury due to *Harmolita vaginicolum* has been severe only in the northeastern counties. This includes ten counties east and northeast of Lorain, Wayne, and Harrison. During 1918 severe loss occured in this section to all wheat sowed after October 1st. Spring wheat suffered the worst. The injury decreased gradually until 1921, when joint-worm, was at a low ebb all over the State. During this year specimens of *H. vaginicolum* were taken along the Ohio River near the southern point of the State and at points in southeastern counties.

The surveyors did not observe any specimens in western Ohio. It is probably generally distributed over the eastern one-half of the State and most abundant in the northeastern section.

Date of sowing plats are maintained at most of the county experiment farms for the purpose of determining the best wheat sowing date through a series of years, and the effect of hessian fly upon wheat sowed at various times. Two of these county experiment farms, namely, Trumbull County and Mahoning County, have had the date of sowing plat going for five years. These counties are located in the section of the State where *H. vaginicolum* is the dominating species. Each year of the Wheat Insect Survey, except one, the writer has inspected these plats to determine the presence of this species and the effect of time of sowing upon its prevalence. In 1919, the data were collected by Mr. J. S. Houser of the Ohio Experiment Station. Usually 200 straws were examined and the percentage of infestation determined for the plat. These are here given for the years 1918—1921.

[2] *Isosoma vaginicolum*, Jour. of Econ. Ent., Vol. 9, No. 5, pp. 398.

PERCENTAGE OF STRAWS INFESTED BY HARMOLITA VAGINICOLUM

1918

*Trumbull County* (Experiment Farm)

| | |
|---|---|
| Sowed Sept 4 | 0% |
| " 15 | Trace |
| " 22 | 11% |
| Oct 1 | 19% |
| " 10 | 32% |
| Spring Wheat | 21% |

Too young to detect.

*Mahoning County* (Stooksberry Farm)

| | |
|---|---|
| Sowed Sept 2nd week | 3% |
| Oct. 1st week | 16% |
| Nov 1st week | 44% |

1919

| | |
|---|---|
| Sowed Sept 9 | 0% |
| " 18 | 0% |
| " 23 | 0% |
| Oct 1 | 0% |
| " 10 | 0% |
| Spring Wheat | 67% |

(Experiment Farm)

| | |
|---|---|
| Sowed Sept 4 | 0% |
| " 18 | 0% |
| " 23 | 3% |
| " 30 | 5% |
| Oct 11 | 28% |
| " 20 | 44% |

1920

| | |
|---|---|
| Sowed Sept 3 | 0% |
| " 9 | Trace |
| " 16 | " |
| " 20 | " |
| " 23 | " |
| Oct 2 | 1% |
| " 14 | 10% |
| " 23 | 22% |

Spring Wheat. Too young to detect.

| | |
|---|---|
| Sowed Sept 2 | Trace |
| " 12 | 0% |
| " 19 | Trace |
| " 30 | " |
| Oct 10 | 5% |
| " 22 | 19% |

1921

| | |
|---|---|
| Sowed Sept 29 | Trace |
| Oct 7 | " |
| " 15 | ½% |
| " 26 | 1% |
| Nov 5 | 2% |
| Spring Wheat | 1% |

| | |
|---|---|
| Sowed Sept 1 | ¾% |
| " 10 | ⅛% |
| " 20 | 1½% |
| Oct 4 | 3% |
| " 9 | 6% |
| " 20 | 11% |
| Spring Wheat | 7% |

Too young to detect.

From the data in the tables, it is seen that a very good control is secured in northeastern Ohio by avoiding the sowing of wheat after October 1st. Late sowed wheat and spring wheat suffered the most, the latter being very severely damaged, altho this damage did not show up until after the winter wheat was harvested.

The control of this species does not necessarily conflict with the control of hessian fly, when we consider that the fly-free sowing dates for this section of Ohio commence about September 23rd. There is then a period of time between the first fly-free dates and the first date of serious infestation from *H. vaginicolum*, during which time wheat may be sowed and avoid both insects. The length of this period apparently varies with the season, but it is usually sufficient to avoid a serious outbreak of either. In most years, sowing during this period of immunity will give protection from both of these insects.

# SOURCES OF INFESTATION OF *THRIPS TABACI* IN IOWA

By J. L. Horsfall, *Dubuque College, Dubuque, Iowa*

While employed as entomological assistant by the Iowa Experiment Station during the summer seasons of 1917–'18–'19 the writer was engaged in investigations of the Onion Thrips. During these investigations the following data were of particular interest in their bearing on the problem. In the vicinity of Davenport, Iowa, some five hundred acres are devoted to onion culture. From five to ten percent of this acreage is planted in set onions for the early market while the larger amount is grown from seed.

Records show that the thrips will establish themselves and begin breeding on set onions from two to three weeks earlier than on seed onions. From our life history studies we found fifteen days to be the average life cycle for *Thrips tabaci* during the last two weeks in June.

Thus the thrips have an opportunity to produce an early generation on the set onions. These will infest the seed onions in far greater numbers than would be the case were there no set onions grown in the neighborhood. Consequently, wherever set onions are planted in the vicinity of seed, they have proven a source of infestation for the later crop and it is doubtful whether the larger returns realized from the early crop compensate for this damage.

On June 24, 1919, the writer was called to investigate a report of thrips infestation in a 5 acre field of seed onions near Davenport. The onions in an area covering 4 square rods in the western corner of the field showed the characteristic yellowish "blight" which always indicates a severe infestation of thrips. This same field had been visited in the summers of 1917–'18 and was practically free from thrips both years. Across the fence from the infested corner was a 10-acre field of alfalfa which had been planted in 1918. This field had been in corn in 1917. The nearest field of onions to the west was two miles distant. On June 22, two days before the visit mentioned, the first cutting of alfalfa had been taken off. While the alfalfa was being cut the air was filled with flying thrips. This was mentioned especially by the farmer across the road who noticed them alighting on his clothing. The prevailing wind that day was from the east. Considering the above facts, it is evident that the alfalfa must have been the place of hibernation for the thrips and when this was cut they were induced to migrate. Since these insects fly with the wind they would only be carried over the west corner of the onion field. The resulting spread in this field was traced

from. day to day as shown by the accompanying diagram (Figure 11). By the end of three weeks practically three-fourths of the field had been damaged.

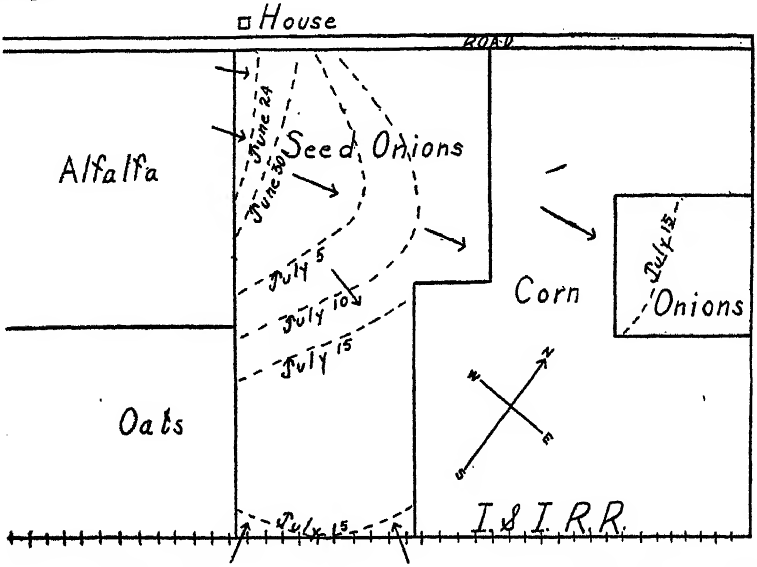



Fig. 11 Diagram illustrating infestation of onion field by THRIPS TABACI which had hibernated in field of alfalfa.

It is interesting to note in this connection that an adjacent cornfield did not serve as an obstruction to the spread of thrips as has often been supposed. By July 15, not only was the north end of the field covered by the pest, but also an area of "white blast" was to be found on the west side of a smaller field beyond the corn. The thrips had moved over the corn from the large field already mentioned. Control measures were attempted by the use of two knapsack sprayers, applying the nicotine sulphate spray advised by the U. S. Dept. of Agriculture, but negative results were obtained. Three hundred bushels of onions were harvested by this man from the five acres. This represented a loss of 75% over his 1918 crop. This loss was directly due to the infestation, since surrounding fields which were free from thrips yielded as much as four hundred bushels per acre under the same conditions of temperature and precipitation. Adults of *Thrips tabaci* were found in the alfalfa blossoms July 30 after the 1919 onion crop was harvested. It will be interesting to determine whether or not thrips will continue to winter over in the alfalfa field in the future and thus continue to menace the onion crop in that vicinity.

One serious outbreak of thrips in a field of set onions near Davenport was directly traceable to the fact that adjoining the sets the grower had six rows of perrenial multiplier onions. The thrips had wintered over on these and thus had an opportunity to begin breeding early. By June 19, they had spread over the first twenty rows of set onions seriously checking their growth. The further spread in this field was checked by the use of a Hardie barrel sprayer with hose extension to run between the rows. Nicotine sulphate–soap formula was employed.

Another source of spread was the greenhouses of the Davis Floral Co. near Davenport, Iowa. This concern is a large producer of hothouse tomatoes and cucumbers. Here the thrips had a chance to breed on the cucumbers through the winter and in the spring they spread from the houses to onion fields in the neighborhood. The first infestations noted in the fields in three different directions from the greenhouses were, in every case, on the side of the field nearest the greenhouses. Then, too, these attacks occurred from two to three weeks earlier than the infestations in other sections of the onion growing district. Attempts made by this company to grow onions in the near vicinity of the houses failed because of this early infestation by thrips which had emerged from the cucumber houses after breeding there during the winter.

One field of seed onions was visited in Mitchell County, Iowa, on August 26 where the source of infestation was very evident. This field of 10 acres was bordered along the east, south, and west sides by spruce trees forming a windbreak. At the east end of the field, well under these spruce trees, was a long pile of refuse where the tops and screenings of the 1918 season had been thrown when hauled from the field. An area heavily infested by the thrips was found to extend around the three sides of the field bordered by the spruce, but this area extended in the farthest at the east end. The thrips had evidently wintered in this pile of refuse and in the matted grass under the spruce.

A few other sources of infestation might be listed in addition to those already enumerated. In all cases they were factors because they had furnished protection to hibernating adults during the winter. In one field an area bordering an implement shed was the first part to become affected by the thrips. The tops of these onions were noticeably yellow while the rest of the field was still green. Upon examination, the tops of the onions near the sheds were found to be swarming with thrips whereas these insects could only be found deep in the sheaths of the onions over the rest of the field. In a field adjoining an orchard, the semi-circular region of "blast" appeared bordering the orchard. Where bluegrass and weeds along creeks, roads, or railroads were not burned,

an infestation usually resulted in the bordering onion fields. One field which bordered the railroad was practically free from thrips in 1919. When the grower was asked about his practice as to this, he answered that if the railroad company did not burn the grass in the fall and spring he always made it his business to see that it took fire. The matter of destruction, where possible, of places of hibernation is a phase of the problem of control which has been neglected too often by the growers, and yet it is one of the most powerful factors. Elimination of the sources of infestation is far easier and more economical than checking the pest after the outbreak begins.

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## WHITE-ANT-PROOF WOOD FOR THE TROPICS

By T. E. Snyder, *Specialist in Forest Entomology, Bureau o, Entomology, U. S. Department of Agriculture*

It is well known that white ants or termites are extremely destructive in the Tropics and that the woodwork of buildings and furniture must be constructed either of woods naturally resistant to attack or of woods chemically treated to prevent attack and rapid destruction.

Foreign manufacturers advertise "ant-proof" furniture for South American trade; American manufacturers have, as yet, not seriously competed.

Wood-pulp products, such as composition, ply and laminated wall boards, manufactured in the United States, also demand chemical treatment before they can be used in the Tropics.

Rather discouraging to American manufacturers, is the fact that due to spoiling the wood for fine finishing, cabinet woods can not be treated by the usual effective chemicals. A solution is given in the use of ant-proof woods imported from South America and other tropical countries as veneers glued upon cores of cheap American woods chemically treated. This well-known expedient is satisfactory, but there are other solutions of the problem.

A number of woods grown in the United States are very resistant to attack by white ants. Hence, since many of these woods are suitable for use as veneers, it is not necessary to import timber from the Tropics.

Furthermore, there is a chemical treatment for cabinet woods that, while it will somewhat darken the wood, if the wood is properly treated, permits shellac or varnish to adhere, and a suitable finish can be obtained. Wood treated with this chemical is both white-ant-resistant and

moisture-proof. The cost of this treatment is justified by this double effect and the fact that cabinet woods impregnated with this chemical can be advertised as white-ant-proof.

Wood-pulp products also can be rendered white-ant-proof by adding poisons in the process of manufacture.

## Naturally Resistant Woods

In 1912 the Branch of Forest Entomology of the Bureau of Entomology, U. S. Department of Agriculture, began a series of tests of the relative effectiveness of treatments with chemical wood preservatives against attack by white ants at a field station at Falls Church, Va. In connection with these experiments, other service tests of the relative resistance of various native and tropical untreated woods to attack by white ants were begun in 1913.

The preliminary results of these tests, which are as yet incomplete and not conclusive, give some data of value. Certain species of wood appear to be naturally highly resistant to attack by white ants. This is not due to the element of hardness, since these insects will attack the hardest known wood, Lignum-vitae, but due to the presence in the wood of substances such as oils, alkaloids, etc., which are repellent or distasteful to white ants.

Normally the wood of pines is most susceptible to attack by white ants, but in case of certain pines with an extremely resinous heartwood, such as the "fatwood" of longleaf pine (*Pinus palustris*) of the southern United States, this is immune to attack by white ants; the excess of resin is a preventative. There is also some inherent principle in the heartwood of the red cedars (species of *Juniperus*) which renders it distasteful to white ants.

Species of native woods which might be used as veneers over chemically treated woods, or as ply or laminated woods, are listed in Table I, with their distribution in the United States, and their relative resistance to attack by white ants.

A few species valuable or which might prove useful for other purposes are also listed in this table.

## Chemical Treatments for Finished Forest Products

The treatment for cabinet woods is impregnation with chlorinated naphthalene—a crystalline wax—by placing it in open vats of the wax, at a temperature of from 220 to 240° F., without previous drying of the wood[1]. The wood remains in the vats for periods varying with the dimensions of the wood; wood of ½ inch thickness requires but 15 minutes.

[1]Process devised by the Western Electric Company of New York, N. Y.

TABLE I. RELATIVE RESISTANCE OF SOME IMPORTANT[1] NORTH AMERICAN WOODS TO ATTACK BY WHITE ANTS (*Reticulitermes* spp.) AFTER A FIVE-YEAR TEST IN THE GROUND IN VIRGINIA

| Species of Wood | Distribution in the U. S. | Degree of Resistance of Heartwood to White Ants. In Test. | In Nature.[2] |
|---|---|---|---|
| Longleaf pine (*Pinus palustris*) | Southern U. S. | Heartwood ("fatwood") not attacked | Not attacked |
| Western larch (*Larix occidentalis*) | Cascade Mts. to Columbia River and to West. Mont., also Blue Mts.—Wash. & Ore. | Heartwood attacked, after 1½ years' test. | No data |
| Bald cypress (*Taxodium distichum*) | Southern U. S. | Heartwood not attacked | Attacked |
| Big tree (*Sequoia washingtoniana*) | Local in California | Heartwood not attacked | Not attacked |
| Red wood (*Sequoia sempervirens*) | Coast region of So. Oregon and California. | Heartwood not attacked | Not attacked |
| Incense cedar (*Libocedrus decurrensr*) | Oregon, California and Nevada. | Heartwood not attacked | Not attacked |
| Giant arborvitae or western red cedar (*Thuja plicata*) | Local in Southern Calif. | Heartwood not attacked | Not attacked |
| Monterey cypress (*Cupressus macrocarpa*) | Pacific Coast and Western slope Rocky Mts. | Heartwood not attacked | Attacked by *Kalotermes minor* Hag. in Calif. |

[1]Species of woods badly attacked after 1 year's test are not listed, including:—pines, tamarack, spruce, Douglas fir (*Pseudotsuga taxifolia*), firs (*Abies*) and arborvitae (*Thuja*); also many hardwoods.

[2]Results based on observations in the field of the resistance of the wood under natural conditions where the tree grows.

| Species of Wood | Distribution in the U. S. | Degree of Resistance of Heartwood to White Ants — In Test | Degree of Resistance of Heartwood to White Ants — In Nature.[2] |
|---|---|---|---|
| White cedar (*Chamaecyparis thyoides*) | Eastern U. S. | Heartwood not attacked | Attacked |
| Yellow cedar (*Chamaecyparis nootkatensis*) | Washington and Oregon | Slight attack after 1½ years' test. | Not attacked |
| Port Orford cedar (*Chamaecyparis lawsoniana*) | Southwest Oregon to California | Slight attack, after 1½ years' test. | Not attacked |
| Red juniper or red cedar (*Juniperus virginiana*) | Eastern and Central U. S. | Heartwood not attacked | Not attacked |
| Western juniper (*Juniperus occidentalis*) | Western Idaho, Cascade & Sierra Nevada Mts. to So. California. | Heartwood not attacked | Not attacked |
| Black walnut (*Juglans nigra*) | Eastern and Central U. S. | Heartwood attacked, after 2 years' test. | Attacked |
| Mesquite (*Prosopis juliflora*) | Southwestern U. S.—So. Okla. and Northern & Western Texas to So. California. | Heartwood not attacked | Attacked by *Amitermes wheeleri* Desn. in Texas. |
| Mahogany (*Swietenia mahogoni*) | Florida Keys | Heartwood attacked, after 2 years' test. | No data. |

After removing the wood from the vats it should be carefully wiped off with cloth. The resultant color will be somewhat darker than the color of the untreated wood; care must be exercised in thoroughly cleaning the surface of the wood to insure the proper adherence of shellac or varnish.

The amount of wax taken up in the above treatment will vary with the different species of woods—whether they are open-pored or not—and according to the condition of the wood to be treated. A representative group[1] of both softwoods and hardwoods were treated with chlorinated naphthalene for our tests. This treatment renders the wood both white-ant-proof and moisture-proof to a marked degree. When treated with chlorinated naphthalene these sample sections of North American hardwoods, susceptible to attack if untreated, were not attacked, after burial in the ground for over three years with logs infested with white ants or termites (*Reticulitermes* spp.) in Virginia. After this severe test in the ground these treated woods compared favorably with untreated teak and mahogany as to general condition.

Similar samples of woods treated with paraffin wax were readily attacked by white ants and also suffered decay.

## Chemical Treatments for Crude Forest Products

Construction timbers or other timber which is to be in contact with the ground should be impregnated with coal-tar creosote, which is a permanent preventative against attack by our native white ants or termites. Coal-tar creosote has many properties which would recommend its use in this respect, for it is also a fungicide, and, being insoluble in water, will not leach out in wet locations. These requirements furnish objections to many chemicals that otherwise are very effective insecticides.

The various methods of superficially treating timber, as by charring, by brushing, or by dipping with various chemical preservatives, among which are coal-tar creosotes, carbolineums, etc., have proven to be temporarily effective in preventing attack if the work is thoroughly done.

If the wood is not in contact with the ground, impregnation treatments with bichlorid of mercury and zinc chlorid are effective. The mercury and zinc in this form are both soluble in water.

[1]White pine (*Pinus strobus*), black walnut, sweet birch (*Betula lenta*), chestnut, white oak (*Quercus alba*), red oak (*Quercus rubra*), sweet gum (*Liquidambar styraciflua*) mahogany (*Swietenia mahogoni*), sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*).

The last named chemicals would be suitable treatments for cheap perishable woods to be used as the core, over which ant-proof veneers could be glued.

## Chemical Treatments of Wood Pulp Products

In case of ply or laminated wall "boards" made of wood pulp, these boards may be made highly resistant to attack by white ants by adding poisons during the process of manufacture. Such poisons include solutions of bichlorid of mercury, carbolic acid, etc. Coal-tar creosote can be added where the brown stain and odor which are imparted to the board are not objectionable.

While white ants of the Tropics are more numerous and, as a rule, more destructive than those native to the United States, it is evident that if treated or untreated woods are resistant to attack by our native white ants (*Reticulitermes* spp.) after a severe five-year test in the ground, they will not readily be attacked when above ground by white ants of the Tropics; especially since our native white ants (*Reticulitermes* spp.) wherever they occur throughout the world are among the most destructive species to wood.

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**Opisthuria clandestina var. dorsalis Knight Injurious to Legumes.**—In July of 1919 Mr. W. C. Abbott of the Extension Division of the Louisiana State University brought to the writer adults of a species of the heteropterous family Miridae, together with nymphs that appeared to belong to the same species, stating that they were taken from cowpeas, which they appeared to be injuring near Baton Rouge, La. No other observations concerning the habits of the species came to our attention until July 26, 1921, when adults and nymphs were found to be numerous on pole beans on a farm near Baton Rouge by Mr. W. G. Bradley, Assistant Entomologist of the Louisiana Experiment Stations. The upper surfaces of the leaves of these beans showed small white spots, often so numerous and close together as to give the surface a whitened appearance, similar to that caused by certain species of mites and thrips in their feeding on leaf tissue. The undersides of the leaves showed no signs of injury. The damage was so severe that the farmer had attempted to control the insect. Nymphs that were collected were carried through to the adult stage in confinement on bean leaves on which they caused the same type of injury as noted in the field.

A few adults and nymphs were also noted on soy beans on the Experiment Station farm at Baton Rouge during 1921.

Specimens collected from beans by Mr. Bradley have been referred to Dr. H. H. Knight of The University of Minnesota and determined by him as *Opisthuria clandestina* var. *dorsalis* Knight.

Thos. H. Jones, *Louisiana Experiment Stations*

## LEAFHOPPERS INJURING WOODBINE

By Geo. W. Barber, *Cereal and Forage Division, U. S. Department of Agriculture*

For the past two years the writer has noticed, from time to time, in several localities in Eastern Massachusetts, American Woodbine, *Speurer* spp. (*Ampelopsis, Parthenocissus*), injured by leafhoppers. During the season of 1920 it has been possible to determine the species concerned and to learn something of their life-histories and habits.

The following species are recorded:

*Erythroneura comes var. comes* Say.
Franklin, Aug. 22, 1920.

*Erythroneura comes var. ziczac* Walsh.
Arlington, June 3-14, 1920; Franklin, Aug. 22, 1920.

*Erythroneura comes var. elegans* McAtee.
Lexington, April 16, 1920; Franklin, May 30, 1920;
Arlington, June 10, 1920; Franklin, Aug. 22, 1920;
Cambridge, Aug. 1919.

*Erythroneura vulnerata var. vulnerata* Fitch.
Franklin, May 30, 1920; Arlington, June 10, 1920;
Franklin, Aug. 22, 1920.

*Erythroneura vulnerata var. nigra* Gillette.
Arlington, June 3, 1920; Sudbury, July 6, 1920;
Franklin, July 28, 1920; and Aug. 26, 1920;
Lexington, July 28, 1920; Woburn, Sept. 3, 1920.

Of these forms *E. vulnerata var vulnerata* and *E. comes var. elegans* were throughout the season most numerous in the several localities, both being found together. *E. comes var ziczac* was at times abundant but *E. comes var. comes* and *E. vulnerata var. nigra* were infrequently seen and doubtless were present in small numbers.

The leaves by midsummer appear blotched and discolored, beginning to fall by the last of June. The continual falling of leaves is the most disagreeable feature of the insect attack where the plants are growing as shade for porches and summer houses.

Both species probably spend the winter as adults, since they were both taken in May to June before nymphs were in evidence. At that time the adults were few in number but by the middle of July were very numerous, together with nymphs of all stages. By September several instances were noticed where the remaining leaves on certain

vines were all spotted and the insects were most abundant. It seems probable that there are two and three broods in the latitude of Massachusetts.

Control of the species is rendered difficult in cases where the vines are climbing on the walls of buildings, since the nymphs are nearly all on the underside of the leaves and difficult to reach with a spray. Where the underside of the leaves can be reached, as on open porches and summer houses sprays of soap or nicotine solutions may be used and the writer has obtained effective control from a strong spray of water applied under considerable pressure and at intervals, directed towards the under surfaces of the leaves.

## A SEED POTATO MAGGOT (*HYLEMYIA TRICHODACTYLA* RONDANI)

By O. A. Johannsen, *Ithaca, N. Y.*

On June 27, 1910, I bred male specimens of an Anthomyiid fly, *Hylemyia* (*Phorbia*) *trichodactyla* Rondani from maggots infesting a lot of seed potatoes which had been forwarded to the Maine Agricultural Experiment Station from Aroostook Co., Maine, by a farmer who said his potatoes were severely infested.

Concerning the habits of this species but little has been published, though the adult fly is not uncommon. In the Cornell University Collection are specimens from Aroostook Co., Maine, Peru, N. Y., Ithaca, N. Y., Sandford, Ontario, and Truro, Nova Scotia; the collection dates ranging from May to July. Dr. O. Oberstein (Zeitschrift f. Pflanzenkrank. 24:385, 1914) records this species as injuring young cucumber plants in Lower Silesia where a one-half acre field under observation showed 80% injury. The maggots mined in the stems of the young plants causing them to die in a few days. When full grown the larvae descended into the soil where they pupated. The specimens which I had under observation remained in the pupal stage about one week.

As the fly has a wide distribution and is fairly common, it is not unlikely that it is of economic importance in the United States also, but by reason of its great similarity to the seed-corn fly (*Hylemyia cilicrura* Rondani $=$ *H. fusciceps* Slingerland not Zetterstedt), it may have been mistaken at times for this species. The males of these two forms resemble each other in having the hind tibia ciliated on the inner (flexor) side (See Slingerland, Bulletin 78, Cornell Agricultural Experiment Station page 495), but differ in that *H. trichodactyla* has a few

long bristly hairs on the upper (extensor) side of the basal segment of the middle tarsus. For lack of bred material in which both sexes are associated, the female has not yet been sufficiently studied to distinguish it with certainty from that of *H. cilicrura*.

As for the larvae, the imported onion maggot, *Hylemyia antiqua* (=*cepetorum*), the seed corn maggot, *H. cilicrura*, the cabbage maggot, *H. brassicae*, and the seed potato maggot, *H. trichodactyla*, also resemble each other rather closely. The distinctive features of the first and third, are figured in Bulletin 200, N. J. Agr. Exp. Station, page 7; and the first three are figured by Gibson in Bulletin No. 12, Dept. of Agr., Dominion of Canada, 1916, page 12. The differential characters of the fourth, based on a study of my specimens, are given below. In *Hylemyia antiqua* and *H. cilicrura* the ventro-caudal papillae are simple; in *H. brassicae* and *H. trichodactyla* the two median ones are bifid. The last named species may further be distinguished from *H. brassicae* by the more distinctly chitinized condition and yellow color of the bifid papillae, the smaller size, and by the form of the mouth hooks. In *H. brassicae* the mouth hooks are robust and nearly smooth below; in *H. trichodactyla* they are smaller, slightly more pointed and slender, and uniformly serrate with about ten small teeth on the concave margin.

Until more light can be thrown upon the grouping of the closely related genera of the subfamily Anthomyiinae, I prefer to unite under the generic name *Hylemyia*, the genera *Chortophila*, (=*Phorbia*), *Hylemyia* sens. str., and the black legged species of *Pegomyia*.

It is desirable that economic entomologists who are working upon the habits of the Cabbage, Onion or Seed corn fly, keep in mind *Hylemyia trichodactyla*, with the hope that something more may be learned concerning its habits and its relation to farm crops.

## A LAMP FOR TAXONOMIC WORK IN ENTOMOLOGY[1]

By W. J. Phillips and F. W. Poos, *U. S. Bureau of Entomology, Charlottesville, Va.*

Taxonomic work on the genus *Harmolita*, of which many species are differentiated by the sculpturing of the propodia, requires both a magnification by high powered lenses and a very bright light. For this reason the writers have felt the need of better lighting facilities than those afforded by the common gooseneck type of electric lamp. A number of lamps of different manufacture have been tested. While these lamps gave sufficient light they were not only difficult to adjust but developed a great amount of heat, and were not economical in the use of electrical

[1]Published with the permission of the Secretary of Agriculture.

current. Professor A. L. Melander,[1] in 1913, briefly described an adaptation of an automobile headlight which he used for microscopic work. However the advantages of this type of lamp apparently have not been discovered by most taxonomic workers. It was therefore deemed advisable to give a detailed description of the lamp in use by the writers, together with a mounting which has been found most convenient and useful at this laboratory.

The lamp (Fig. 12.) adopted for use by the writers consists of the ordinary Ford spot light which is adjustable in both horizontal and vertical planes and carries a 6—8 volt, 32 candle-power bulb. It is mounted

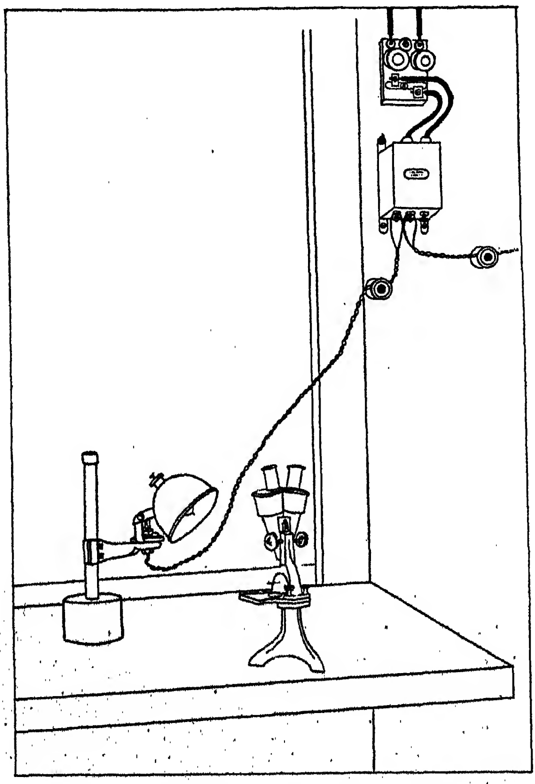

Fig. 12. Diagram of lamp installation.

on a home-made stand consisting of a fifteen inch length of one half inch, iron pipe with an elbow attached to the end which is mounted

[1]Jour. of N. Y. Ent. Soc. Vol. 21, 1913, p.227.

in a cement block. This block was molded in a coffee can and after the surface was smoothed with a trowel somewhat and the cement hardened, two coats of white paint were applied. A covering of felt was placed on the bottom of the stand.

A thordarson, type D, three-way step-down transformer, primary voltage 110, secondary voltage 6—8—14, 60 watt capacity, was used in order to attach the lamp to the ordinary 110 volt alternating current. Wherever direct current is used some other form of resistance will be necessary. It is safest to install a fuse block with fuse plugs of low amperage to protect the transformer. As many as three of these lamps may be attached to this transformer. The cost of this lamp depends upon the kind of transformer used which in turn depends upon the number of lamps desired and the candle-power of the bulbs which are used in the lamps. A rheostat may be used to regulate the intensity of illumination if this is desired. The retail price, at Charlottesville, Virginia, of three lamps, including one transformer as shown in figure 12, was $25.50 or and average of $8.50 per lamp, complete.

The chief advantages of this lamp are as follows: it furnishes a powerful light; develops very little heat; is economical in the use of electrical current; is easy on the eyes; is easily adjusted and installed and at the same time is comparatively inexpensive. These lamps have proven most satisfactory for our taxonomic work and they have also been used advantageously for photographic work with the Leitz Microscopic Camera.

## THE ARGENTINE ANT BUILDS EARTHEN PROTECTIONS FOR MEALY BUGS[1]

By E. O. Essig

One of the most serious problems in connection with the control of many of the serious scale insects infesting orchard trees and other plants in California is the Argentine Ant, *Iridomyrmex humilis* Mayr, which so valiantly keeps away the natural enemies of the coccids.

Wherever the so-called biological method of pest control is employed, it is first necessary to take steps for the control of this ant in order to allow the proper freedom and development of the parasites and predators. For not only does the ant keep away the small hymenopterous parasites, but violently and effectively attacks the larger larvae of the ladybird

[1]Contribution from the Division of Entomology, University of California, Berkeley, California. Dec. 15, 1919.

beetles, lace wings and other allied predators. Besides such protection to the mealy bugs and other coccids, the ants carry them from plant to plant and sees to it that new colonies are constantly being formed until all of the shrubbery in an ant-infested district is well supplied with the plant destroying pests.

A very interesting method of protecting mealy bugs is at present being observed in a greenhouse in Berkeley. As is common in the vicinity, mealy bugs of several species, including the citrus mealy bug, *Pseudococcus citri* (Risso), Baker's mealy bug, *P. bakeri* Essig and the citrophilus mealy bug, *P. citrophilus* Clausen, are abundant; sometimes associated upon the same plant and often upon different hosts. But the Argentine Ant is abundant everywhere giving diligent attention to all. The particular greenhouse in question is given over to the culture of the Cape Jasmine, *Gardenia* sp., all of the plants of which are infested with the citrus mealy bug. The coccids are to be found only in the forks

Fig. 13. Shelters constructed by Argentine ants.

of the branches near the tips of the plants and in some of the leaf axils singly or in small compact colonies. In the majority of cases the colonies are surrounded by very delicate earthen enclosures as shown in the accompanying illustration. These enclosures are usually oval or nearly spherical in shape and vary from a half to a full inch in diameter. The walls are exceedingly thin and delicate, being composed of fine particles

of dirt or leaf mold and attached to the branches of the forks for support. So frail are they that a slight sudden jar will cast them into ruin, but if destroyed the ants at once begin to construct new ones, apparently having already learned of their usefulness. Entrance to the enclosures is gained by one or several openings in the outside walls and through these the ants pass to and fro very freely.

This being the first time that I have seen anything just like this being constructed by the Argentine ant for the specific purpose of enclosing mealy bugs, it seemed worth recording the fact.

## A HOME MADE MECHANICAL POISON BATE MIXER[1]

By B. G. Thompson, *Scientific Assistant, Bureau of Entomology, Cereal & Forage Insect Investigations*

During the grasshopper eradication campaign of the season of 1919 in Harney County, Oregon, which was carried on by the Entomological Extension Service, several mechanical devices were tried out for the mixing of poison bait. The apparatus hereinafter described, proved very successful both as a labor-saving device and as a means of securing an efficient and uniform mixture of poison bait.

The machine (See Fig. 14.) was constructed on the principle of a churn. It consisted of a wooden box 40″ x 40″ x 48″, mounted on a 1¼″ shaft, with a wooden pulley 42″ in diameter, fastened firmly to the end

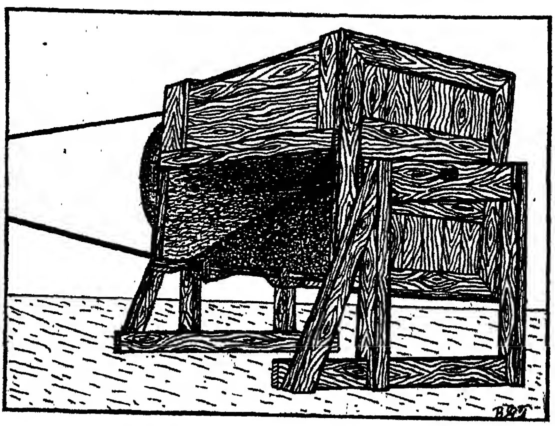

Fig. 14. Poison bait mixer.

of the box. The box was constructed of 1¼″ tongue and grooved lumber. One half of one side was used as a door, thus giving ample

[1]By permission of the Secretary of Agriculture.

room for placing in the materials and taking out the bait. The edge of the door were felted to prevent leakage. No paddles or other obstructions were placed inside the box; the falling of the materials from one corner to another as the box revolved thoroughly mixed the bait.

It was necessary to use a 3½" pulley on the engine to get sufficiently low gear to turn the box about 36 revolutions per minute, which was found to be the maximum speed for best results. A one and one-half horse power gas engine developed sufficient power to operate the mixer. Two men operated it to its fullest capacity.

The machine handled 100 pounds of bran at a time. The bran and poison were placed in the box and mixed for about two minutes. The syrup, ground oranges, or lemons, and water, mixed together, were then added and mixed for from three to four minutes. The fact that there were no paddles or other obstructions in the box made the removal of the bait a simple matter. The bait was shoveled directly from the machine into sacks. This feature proved an advantage over a barrel-shaped mixer which required stationary paddles to thoroughly mix the bait.

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## Scientific Notes

**Effect of Feeding Paradichlorobenzene-Treated Feed to Poultry.** Last summer, corn in the Agronomy Seed Laboratories at Purdue University, was treated with para-di-chloro-benzene to eliminate if possible and to prevent further infestation by the angoumois grain-moth. Subsequently Prof. F. E. Robbins of the Agronomy Department used some of this corn for feeding poultry, resulting in tainting the flesh of the chickens to such an extent as to make it distasteful and inedible. Similarly eggs laid by hens fed this treated corn were equally distasteful and inedible. It has been previously noted that the eggs laid by hens fumigated with nitrobenzene for the control of lice and mites are spoiled for food.

J. J. Davis
*Oct. 31, 1921, Lafayette, Ind.*

**Notes on the Nest and the Population of a Colony of Vespa diabolica.** Prompted by a curiosity to learn something of the population of wasps' nests, I recently captured among others two colonies of *Vespa diabolica*. As is well known these build a nest not unlike that of various species of Polistes; but locate it in the ground instead of in some tree or shrub.

One of the nests was taken on September 26. The entrance on the surface of the ground was about an inch in diameter. It was inlaid with pieces of gravel that were held in place by a paper lining. By pouring a small quantity of carbon disulfide into the entrance the wasps were readily pacified, whereupon the nest with all the inhabitants was easily removed. The nest consists of six stories, and the base is about ten and a half inches in diameter.

The inhabitants of the nest numbered 2090. Of these there were 294 queens, 771 males, and 1025 workers. In the lower two stories there were still a large number of cells containing immature queens. The other nest was taken on August 23. While much smaller than the one just described, it nevertheless, consisted of six stories. The population numbered 146, consisting of 142 workers, 3 males, and one queen.

W. J. Baerg,
*Fayetteville, Arkansas.*

**Artificial Production of Tipburn.** Experiments conducted at the Iowa Experiment Station during the past season have proven that *Empoasca mali*, the potato leafhopper, is a very important factor in the production of tip- or hopperburn of potato. In July solutions were made by crushing a large number of these insects in both the mature and immature stages in sterile water. Small amounts of these solutions were injected into the leaves by various instruments, such as hypodermic needle and dissecting needle, and in every case within 24 hours a lesion was produced at the point of inoculation showing that these insects possess a toxic principle. Difficulty was experienced in getting large amounts of the solution into leaf tissue by these methods but in a few cases enough was injected to produce an injury decidedly similar to, if not identical with tipburn. Burning was produced where the extract was made from crushed adults. In another series of experiments when the young were crushed in a leaf abrasion a small but distinct lesion was produced after 24 hours, the tissue dying and turning brown at these points. When the extract made from crushed young was drawn up into the leaf by the natural transpiration of the plant, burning resulted that was similar to tipburn. In the latter experiments leaves were placed with their cut stems in the leafhopper extract. Solutions made by macerating tipburned leaf tissue in distilled sterilized water were injected into leaves by using a hypodermic needle. No injury resulted from these tests. Leaves inoculated with water alone failed to show injury and when dilute acids or alkalies were injected, the leaves wilted and then turned brown, a condition not comparable to tipburn. The above tests show that the potato leafhopper in both the young and adult stages does contain a toxic principle and that when enough of this is artificially injected into the leaf, tipburn results.

F. A. Fenton and I. L. Ressler
*Iowa Experiment Station*
*Ames, Iowa.*

**Notes on a Bombylid Parasite and a Polyhedral Disease of the Southern Grass Worm, Laphygma frugiperda.**—These notes are based on field observations made at Agricultural College, Mississippi and on records from several series of larvae collected in the field and reared in the laboratory simultaneously with the field observations. The Southern Grass Worm was very abundant in Mississippi during the summer of 1920 and offered an excellent opportunity for study of the parasites of which it is a host.

During the summer of 1920, two agencies of natural control were found in operation against the Southern Grass Worm, *Laphygma frugiperda*. One was a Bombylid parasite and the other a polyhedral disease, probably identical with one mentioned by Chapman and Glaser in the Journal of Economic Entomology Vol. 8, Feb., 1915.

The Bombylid was determined as *Anthrax lucifer* Fabr. by C. T. Greene of the U. S. Bureau of Entomology. The adult, a cloudy-winged, medium-sized bee-fly was observed to be very numerous during the late summer and early fall months,

hovering over pasture and meadow grass. It was reared from the larvae of the Southern Grass Worm in numbers sufficient to indicate that the parasitism was in no sense accidental. The larvae from which this parasite was recovered were taken from a heavy lawn infestation early in September, when about one-half grown. The parasitized larvae pupated successfully, but shortly after pupation, the parasite became fully developed and pupated within the pupal case of its host. After several days spent in this manner, the parasite pupa broke through and twisted itself entirely free from the pupal case of its host. Shortly after this the adult emerged. Since the Grass Worm pupates beneath the surface of the ground it seems quite probable that the active pupae of this parasite twists itself free from the host and works its way to the surface of the soil so that the adult may emerge directly into the open air. Seventy-two pupae were secured in these collections and eighteen or twenty-five per cent were parasitized by *Anthrax lucifer*.

The disease was first noted among nearly full-grown larvae in the same heavy lawn infestation, during the hot, humid weather of early September. Dead larvae in considerable numbers were found hanging from the tips of blades of grass. Those freshly dead presented a yellowish hue, but even in these the process of decomposition had advanced so far that the body contents had been reduced to milky fluid, which would break forth at the slightest pressure on the larval skin. Microscopic examination of a large series revealed that in all cases the body fluids of such larvae were crowded with highly refractive, irregularly angular bodies known as polyhedral bodies, and which are the distinguishing characteristic of one type of caterpillar maladies.

The existence of a polyhedral disease of the Southern Grass Worm has been previously noted, in connection with several diseases of a similar nature, the best known of which is the "wilt" disease of gipsy moth caterpillars.

From the disease infested colony of Grass Worm, two hundred and twenty-nine larvae were taken and maintained individually in glass vials. Of those that died, eighty-five had the typical appearance of polyhedral disease, and showed the presence of polyhedral bodies under the microscope, indicating a mortality of approximately thirty-seven per cent under laboratory conditions. This may have been somewhat higher than in the field, but all the field observations in this infestation indicate that it ran high, very many dead caterpillars being found. No disease of the Grass Worm was noted either in the field or in the laboratory prior to the outbreak mentioned above, although this insect was under observation throughout the season and several series of larvae had been reared in the laboratory during the previous months.

H. W. Allen.

**Eggs of the Potato Flea Beetle** (*Epitrix cucumeris*). I have several times been requested to state the means which were used in obtaining the eggs of the potato flea beetle (*Epitrix cucumeris*), the account of this process having been inadvertently omitted from Bulletin 211, Maine Agricultural Experiment Station. As it may be of interest to Economic Entomologists generally, it is given herewith.

The method is but a modification of one long in use and consists of enclosing beetles in a lantern globe set in a vertical position over a flower pot. The globe, closed top and bottom with cheese cloth, is set upon a piece of black paper kept damp by its contact with the earth in the flower pot. The beetles thrust the tips of their abdomens through the cloth and lay their eggs on top of the paper where they may readily be seen. The insects were captured in the field after the middle of June and soon thereafter laid their eggs.

Later, cages without bottoms were set over potted potato plants, care having been taken that the earth was free from eggs or larvae of any sort. *Sciara* larvae, in particular, are quite apt to be found in rich soil. The eggs of the flea bettle are only 0.25 mm. in length and are thus found with some difficulty at the base of the vines. Plants dug up about three weeks after the cages were charged with beetles, were found to have the larvae at their roots.

In the bulletin above mentioned, there is an error of omission which I take this occasion to rectify. On the bottom of page 42 the following words should be added; —"seed potato in the ground. In New York the larvae have been found boring in the tubers, the wound made resulting in the formation of a". It may also be noted that of all the species of *Sciara* mentioned on page 54 only *S. pauciseta* is North American.

O. A. Johannsen

# Reviews

## An Abstract of the Legislation in Force in the British Empire Dealing with Plant Pests and Diseases up to the Year 1920. By E. Marguerite Ralfs, Imperial Bureau of Entomology, London, pages 1-65, 1921.

This is an exceedingly useful compilation of the rules and regulations in relation to plant pests and diseases and relates, as indicated by its title, to the entire British Empire, including such widely separated parts of the world as Tasmania, Mauritius, various political divisions of Africa, India and Canada and its provinces. The restrictions and requirements are stated in non-technical language and some from the American standpoint would be onerous, if applied to certain areas in the United States, as for example the New South Wales requirement in relation to apple, pear and quince to the effect that infected and fallen fruit must be collected and destroyed regularly. The regulations apply to a large number of insects, plant diseases and plants. The utility of the compilation is greatly increased by a detailed index.

Entomologists will find much of interest in these regulations and those handling an extensive export business should certainly have a copy of this publication.

E. P. F.

Dr. Georgina Sweet, a thoroughly trained zoologist is in charge of the special development along the lines of Economic Zoology, including Medical, Agricultural and Veterinary Zoology, recently inaugurated by the University of Melbourne. The need of literature is at times very acute and she would greatly appreciate publications relating to the above mentioned lines and being placed upon the exchange list of persons and institutions in a position to cooperate, though for the present she can not hope to offer much in the way of exchange. It is a gracious act to assist those remote from the great centers of scientific activity.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

DECEMBER, 1921

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published as far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations as far as possible. Photo-engravings may be obtained by authors at cost. The receipt of all papers will be acknowledged.—EDS.

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Illustrations are extremely valuable adjuncts to scientific papers and their free use should be encouraged, provided they elucidate a point or points and can be employed to as good or better advantage than their equivalent in text. The large amount of copy submitted for publication in connection with high printing rates has compelled most careful scrutiny of illustrations in order to secure the best results. There is no question but that an illustration in a scientific publication should tell a real story. It should do it as well and preferably better than text and applying the test of recent years in regard to printed matter, it should tell a hitherto unrecorded tale. The mere fact that an illustration represents a condition or process not heretofore known or described for one part of the country does not justify the expense of reproduction in a publication having a world wide circulation, though it could undoubtedly be used to excellent advantage in locally distributed literature. Occasionally a considerable series of most excellent photographs are submitted. Limited resources make reductions imperative and in some cases most of the points can be clearly established by using only a portion of the series. Sometimes, an attempt is made to include too much on a plate. A few well engraved figures showing what is desirable are better than a larger number reduced so greatly as to obscure essential features. It is suggested that authors, with the above in mind study critically their illustrative material before submitting it for publication.

# Current Notes

The Laboratory of the Bureau of Entomology at Cornelia, Ga., for the study of the codling moth, has been closed.

The annual meeting of the Michigan State Beekeepers Association was called for December 1 and 2, at Lansing.

Mr. C. R. Cleveland, formerly assistant entomologist at the New Hampshire Station, has been appointed assistant entomologist at the Indiana Station.

The annual convention of the Ontario Beekeepers Association was scheduled to be held at Toronto, November 22–23 in connection with the Royal Winter Fair.

Mr. H. L. Seamans recently appointed Entomologist in charge of the Dominion Entomological Laboratory at Lethbridge, Alberta, reported for duty on March 30.

According to *Science*, Professor F. E. Guyton, of the Ohio State University, has been appointed assistant professor of zoology and entomology at the Alabama Polytechnic Institute.

Professor F. Eric Millen, provincial apiarist of Ontario, has just returned from England where he spent part of his vacation and gave several lectures at meetings of beekeepers.

There has been a severe attack of the corn ear worm, *Chloridea obsoleta* Fabr., throughout southern Canada and the northeastern United States during September and October.

*The Canadian Horticulturist and Beekeeper* has been changed to *The Beekeeper*. Hereafter the publication will be devoted solely to the interests of apiculture and will be published at Petersboro, Ontario, as heretofore.

Mr. Harry Arnold, horticultural inspector of the Canadian Department of Agriculture, was killed at St. Catherines, Ont., October 23, by accidentally falling through an open trap, breaking his neck.

The valuable collection of aculeate Hymenoptera of the late F. W. L. Sladen, including a nearly complete collection of British wild bees, has been acquired by the Entomological Branch, Canadian Department of Agriculture.

Dr. J. M. Swaine of the Entomological Branch, Canadian Department of Agriculture, was elected President of the Professional Institute of the Civil Service of Canada at the annual meeting held in Ottawa, on November 1.

Mr. J. C. Bridwell of the Bureau of Entomology, when in New York recently made a study of the bruchid types of Schaeffer. He was fortunate in securing for study in Washingon the entire collection of Bruchidae belonging to Mr. Schaeffer.

Mr. Quincy S. Lowry, assistant director, Division of Plant Pest Control, Department of Agriculture, Boston, Mass., visited New York City and New Haven, Conn., on his vacation during the first week in November.

The annual convention of the Chicago Northwestern Beekeepers Association has been scheduled for December 5 and 6, at room 1811, Hotel La Salle, Chicago. Mr. John C. Bull, Valparaiso, Ind., is the Secretary.

Mr. W. O. Hollister, of the Davey Institute of Tree Surgery, Kent, Ohio, is President of the local Chamber of Commerce and has recently been elected mayor of the City of Kent. He takes his office January 1, 1922.

Mr. R. C. Treherne of the Vernon, B. C., Laboratory, has recently been appointed Chief of the Division of Field Crops and Garden Insects, Entomological Branch, Canadian Department of Agriculture, and took up his new duties in Ottawa, October 6.

The Alabama Beekeepers Association held its annual meeting at Montgomery on September 22. Steps were taken to secure a foul brood law at the forthcoming session of the legislature. It is stated that more bees and queens are reared within 150 miles of Montgomery than in any other equal section of the United States.

The following temporary officers resigned during October from the Entomological Branch, Canadian Department of Agriculture: G. M. McFarlane, junior entomologist, Saskatoon laboratory; Geo. Makinson, inspector, Nova Scotia; H. H. Thomas junior entomologist, British Columbia; A. H. McAndrews, spruce bud worm investigator, New Brunswick.

The following employees of the Bureau of Entomology have resigned to return to their studies in college: R. H. Turner and W. P. Whitlock, field assistants, Mexican bean beetle control; Bernard Smit, bean weevil investigations, Alhambra, Calif., to resume graduate work at Cornell University.

The following recent transfers in the Bureau of Entomology, U. S. Department of Agriculture have been announced: L. W. Brannon, D. M. Dowdell, Jr., H. B. Lancaster, F. R. White, temporary field assistants, Mexican bean beetle work, to plant quarantine inspectors, truck-crop insect investigations; M. H. Atwood, F. I. Jeffrey, E. G. Small, temporary field assistants, Mexican bean beetle work, to plant quarantine inspectors, Federal Horticultural Board; F. P. Bickley, Mexican bean beetle work to scientific assistant; E. R. Van Leeuwen, codling moth work at Cornelia, Ga., to camphor scale control, New Orleans, La.; A. J. Ackerman, Sacramento, Calif., to Bentonville, Ark., in charge of laboratory for apple insect investigations.

A conference was held on November 18, at 10:00 A. M., in the State House, Boston, Mass., to consider the gipsy moth situation, particularly the recent spread, the Federal and State appropriations and the outlining of a definite policy of carrying on the work for the coming season. This conference was called by Mr. William A. L. Bazeley, Commissioner of Conservation and State Forester of Massachusetts, and the conference was held in his office. The following were present: Prof. W. C. O'Kane, W. A. Osgood, New Hampshire; Harold L. Bailey, Vermont; W. A. L.

Bazeley, C. O. Bailey, G. A. Smith, Massachusetts; Dr. W. E. Britton, Connecticut; Dr. E. P. Felt, Dr. Geo. G. Atwood, New York; Messrs. A. F. Burgess, H. L. McIntyre and D. M. Rogers, Federal Bureau of Entomology.

On the night of November 2, 1921, a fire destroyed the building in which the Experiment Station laboratories of the Louisiana State University were housed. In common with other departments, the Department of Entomology lost all equipment, notes, specimens, publications, photographic plates, and correspondence. The Division of Truck Crop Insects of the U. S. Bureau of Entomology, which maintained a field station at Baton Rouge in co-operation with the Louisiana State University, also lost equipment, notes and specimens contained in the building.

Messrs. Strickland and Seamans of the Lethbridge, Alta. Laboratory, Entomological Branch, Canadian Department of Agriculture, visited Havre and Great Falls, Montana, the latter part of September to investigate the trap work being done in connection with the pale western cutworm. Bait traps at Havre show that more females than males are caught. Light traps are being used over a large area near Great Falls, the farmers have put 240 traps at the rate of one to a quarter section, and as large catches have been made, seem satisfied that the light traps are practical. Experiments on grasshoppers and cutworms are still being continued.

The following temporary officers resigned during September from the Canadian Entomological Branch: F. H. Randolph, Junior Entomologist, Mosquito Investigations; J. D. Sutherland, Insect Pests Investigator, Hemmingford Laboratory: R. S. Hawkins, Experimental Farms Assistant, Natural Control Investigations; R. N. Bissonette, Junior Entomologist, Division of Field Crop and Garden Insects; P. E. Donat, Insect Pests Investigator, Insecticide Investigations; H. A. Robertson, Junior Entomologist, Treesbank Laboratory; W. Carter, Junior Entomologist, Lethbridge Laboratory; R. H. Mowat, Experimental Farms Assistant, Division of Forest Insects; R. H. Painter, Insect Pests Investigator, Corn Borer Investigations; A. E. Cameron, Entomologist, Saskatoon Laboratory; G. P. Garlick, Junior Entomologist, Vineland Laboratory.

Prof. H. F. Wickham of the University of Iowa, special field agent in Mexican bean beetle investigations, Bureau of Entomology, returned September 21 from a preliminary survey of the Mexican bean beetle in its native home, Southern Mexico. Prof. Wickham entered Mexico August 6, and proceeded to Mexico City, which was made the headquarters for the investigations undertaken. Many observations were made on the growing of beans in the lowlands and in the mountains extending as far as an altitude of 10,000 feet. A number of varieties of beans were secured for experimental purposes, and observations with special reference to securing natural enemies and parasites were begun. In the vicinity of Cuernavaca the bean beetle occurred abundantly on wild legumes and was a most important bean pest. Near Orizaba the few beans found in cultivation were badly damaged. The beetle was not found in the vicinity of Guadalajara in Jalisco, although its nonoccurrence is not explained. A single specimen of a dipterous parasite of the larvae hitherto unknown was collected. Some promising information was obtained which completely justifies a more extensive investigation during the coming summer.

# INDEX